Jordan Solar One

Environmental Impact Assessment study of the Photovoltaic Plant and the Transmission Line Route Project in North Jordan (Husha and Buwaida areas)

Final Report

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Prepared by
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Executive summary

Introduction

The electricity sector in Jordan is governed by the General Electricity Law (Temporary Law No. (64) For the Year 2002), which empowers the Ministry of Energy and Mineral Resources (MEMR) to establish policies and general rules for the power sector. This law creates an independent Electricity Regulatory Commission (ERC) to protect the interest of consumers and investors, approve tariffs, and grant licenses for generation and distribution of electricity, including tariffs for independent power producers. Electricity tariffs are largely cost reflective with some cross-subsidies embedded in the tariff structure.

The government has since prepared a draft "unified" energy law, which covers the power sector (by including the existing General Electricity Law), the oil and gas sector, and renewable energy (by including the Renewable Energy Promotion Law). The draft energy law proposes to establish a single energy regulatory agency for the electricity and oil and gas sectors, which would subsume the existing ERC.

In order to promote and facilitate investments in renewable energy and energy efficiency, revised renewable energy legislations included under the draft Energy Law have been approved by the new Government under a separate Renewable Energy and Energy Efficiency (REEE) Law. The new REEE law was also approved by the Royal Court and became effective in February 2010. With this recent approval of the REEE, the Government of Jordan has taken an important step towards achieving its ambitious 10 percent-target for renewable energies in the total energy mix by 2020. In the electricity sector, this could translate into a RE capacity of 1,600 MW of which 600 MW is targeted from solar in the total generation mix by 2020.

JSO intends to develop a PV Plant with maximum export capacity of 20 MWac in Husha area of Mafraq Governorate and to establish a transmission line of 33 kv between the PV plant and the Al Hasan electric substation (132/33 kv) in Ramtha district of Irbid Governorate which is located at a distance of 13 km north west of the PV plant to dispatch the generated electricity in the proposed PV plant. The proposed project will have cost such as to include land leasing, professional services, operation, the licenses and permits, and construction.

To meet the Jordanian environmental regulations, in particular, The Environmental Impact Assessment By Law No.37/2005 under the environmental protection law No.52/2006, and **IFC's** applicable requirements, **JSO** has to prepare an Environmental Impact Assessment (EIA) study for the above said project through a qualified consulting firm specialized in conducting environmental studies. To conduct this study, JSO selected Al-Shamil Engineering to conduct the study according to the regulations and the requirements of the ministry of the Environment and IFC.

Project Objectives

The overall objective of the project is to support the rationale and sustainable use of alternative energy resources in Jordan. However, the objectives of this project are as follows:

- Establish a photovoltaic (PV) plant at the proposed site, which is located at Husha area and to connect it to the national electricity grid in the northern part of Jordan through construction and operation of a transmission line of 33 Kv for a distance of about 13 km.
- Develop awareness and capacity building to demonstrate and promote the reliability and potentials of the selected PV plant.
- Contribute to the implementation of the Jordanian renewable Energy Strategy.
- Boost interest of private sector in renewable energy technologies.
- Establish an educational fund to provide scholarships for the disadvantaged students from the local community.

Legislative and Regulatory Consideration

The proposed project with its two components (PV plant and the TL) must comply with several local laws, bylaws, regulations and standards, as well as pertinent international standards. Thus, Al Shamil Engineering team provide a brief summary of the pertinent regulations and standards governing environmental quality, health and safety, protection of sensitive areas, siting, land use control, etc… at local, national, regional, and international levels. Some of the regulatory authorities have jurisdiction over this project. These authorities include but are not limited to Minister of Energy & Mineral Resources, Ministry of Environment, Ministry of Public Health, Ministry of Water and Irrigation, Ministry of Public Works and Housing, and general civil directorate. This study considers both national and international legislations.

An initial list of national environmental and health safety legislations relevant to the proposed project in the construction, operation and decommissioning phases are presented in the EIA study report.

The EIA of the proposed project is also based on internationally respected procedure recommended by the World Bank, covering environmental guidelines. Reference will be made to the IFC Performance Standards (PS) on Environmental and Social Sustainability; which include the followings:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
- Performance Standard 2: Labor and Working Conditions
- Performance Standard 3: Resource Efficiency and Pollution Prevention
- Performance Standard 4: Community Health, Safety, and Security
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 8: Cultural Heritage

Project Location

The proposed project comprises two components, the first component is the photovoltaic plant which is located in north of Jordan/ Husha sub district in Mafraq Governorate at a distance of 80 km from the capital city of Amman, south east of Ramtha city at a distance of 12 km, and north west of Mafraq City at a distance of 12 km, and spans over a number of parcels of Husha land. The total surface area of the proposed PV plant site is estimated at about 1,400,000 m^2 or 1400 Donums. The land of the PV plant site is rented from the owners (Al Qadi family group) for 25 years according to the rental agreement signed by the two parties.

The proposed PV plant site is a part of almost a flat area extended between Hamra and Husha areas with some hills such as Jabal Altunaib which has an elevation of 729 m above sea level closed to Husha Village, the lowest elevation in the area is about 630 m. The area is intersected by small wadies which have trend towards east and west. The main wadi in the area is wadi Al Zarnouq.

The second component of the project is the transmission line, for which two alternatives were discussed, the selected alternative of the transmission line route will be of overhead type, and will cross over public lands for a distance of about 13 km. this alternative starts from the PV Plant and passes through the ROW of Husha road until its intersection with Mafraq – Irbid national road no.10, then it goes west in the ROW of the national road no.10 for a distance of (5 km). The TL then turns south west of the road no.10 through the ROW of planned and approved streets until it reaches the Al Hasan electric substation (132/33 kv) for the distance of about (8 km).

Moreover the proposed project location in relation to biogeographical areas of Jordan, vegetation types, protected areas, specific conservation areas and important bird areas were discussed and consolidated by location maps.

Project Components

Photovoltaic Plant Constituents

The project is to utilize solar energy to generate electric power with a capacity of 20MWac to be connected to the national grid in Jordan. The proposed photovoltaic plant consists of the following main components:

- Solar field: Main components of photovoltaic power plant or "solar field" consists of a large group of semiconductor technology based silicon solar cells arranged in what is known as solar PV panel or solar module. Solar panels convert impinging sun rays (photons) to electrons. The electrons' flow generates direct current (DC) electricity which gets collected and channeled into an electronic device "inverter" to invert the DC current into Alternating Current (AC); the form of electricity used to power homes, neighborhoods, factories, cities, etc.
- Racking: Structural components which support the PV panels. These structures could be stationary (fixed) or movable thru utilizing a "tracking system" to track sun movement during the day, thru out the entire year.
- Tracking: This is a mechanical system attached to the racking system to enable it to track sun movement. This could be a one axis tracking system (similar to the system used in this project) and it could also be a two axis tracking system, as another alternative.
- Other electric and/or electromechanical system components, such as cables, inverters, transformers, switchgear and controls are used to control and condition the power output of the solar field. An inverter is used to convert the electricity which is produced as direct current in to alternating current for the purpose of grid connection. in order to connect a large solar facility to the national grid , numerous inverters will be arranged in several arrays to collect , and convert the produced power
- Connection to the grid: Routing energy generated from solar field to the national electricity grid.

Transmission Line Constituents

The proposed project will involve development of a 13 km, 33 kv transmission line between PV plant in Husha area of Mafraq governorate and Al Hasan sub-station in Ramtha district. To ensure the efficient functionality of the proposed transmission overhead line, all of the transmission line constituents will be installed using the best engineering practices. Following is a brief discussion for the transmission line constituents.

Support Structures

Structures for overhead lines take a variety of shapes depending on the type of line. Structures may be as simple as wood poles directly set in the earth, carrying one or more cross-arm beams to support conductors, or "armless" construction with conductors supported on insulators attached to the side of the pole. It's supposed that concrete poles will be used for the proposed transmission line, and will be designed for the loads imposed on it by the conductors.

For the proposed project, the overhead transmission line consists of about 240 concrete poles along the line route that support the conductor that carry the electricity, a high voltage conductor diameter is used to maximize the carrying capacity. The poles are supposed to be spaced 50 meter interval. Insulators are used to isolate the poles from the conductors that carry the electricity.

Conductors

There are three conductors in the proposed transmission line, which are supported horizontally parallel to each other.

Insulator

Suspension and tension insulator sets of the cap and pin, pin or post type insulator, shackle insulators and stay insulator shall comply in galvanized respects with the requirements of the technical specification for insulator referenced.

All insulators and insulator fitting shall be handled carefully during transportation, assembly and installation on the support structure to avoid chipping or damage and shall be cleaned when installed.

Foundations

The foundation design criteria shall be determined from the classification of the ground into which the structure is to be erected. In general the planting depth of the pole shall not be less than one sixth of the total length of the pole above the ground level, and shall not be less than 1.5 meter.

Project Implementation Phases and Requirements

Pre-construction and Construction phase

PV Plant

The main activities during this phase will be excavation and earthworks for the internal access roads, building of the plant structures and facilities, and installation of photovoltaic panels and modules. The excavation will be conducted to prepare the land of the site for erecting of the structures needed for installing the photovoltaic system.

The equipment to be used in the site preparation and construction phase will require various forms of energy which will include manpower, charged of fossil fuel. Fuel based equipment to be used will include Dozer, loader, mixer, vibrators, compressors, etc… .
This phase also comprises the construction and the paving of the internal roads that have lengths of about 2.5 km to connect the photovoltaic plant facilities together and with the accessible road.

The duration of this phase is expected to be 18 months, during which, it requires the temporarily construction equipments and labors, the equipments include; crane, dozer , jack hummer, loaders, compressors, services vehicles, in addition to the construction material (aggregates, sand, cement, steel, and water and other needed facilities). During this phase, offices and other infrastructure will be constructed. In addition to these equipments, **120 persons** are needed to run all activities of this phase. Those are divided into low skilled workers (construction labor, security staff), semi skilled workers (drivers, equipment operators), and skilled personnel (engineers, land surveyors, project managers). The majority of low skilled employment opportunities associated with the project is likely to benefit members from local communities.

Transmission line

The main activities during the construction phase will be excavation of materials for the poles foundation and installation of poles, conductors, and their support components. Following are the main activities of the construction phase.

- Seclusion of project way leave and clearing
- Excavation for foundation works
- Stinging and Tensioning
- Landscaping

The equipment to be used in project construction will require various forms of energy which will include manpower, charged of fossil fuel. The manual equipment to be used in the development project includes crowbars, spanners and ropes. Fuel based equipment to be used will include mixer, vibrators, compressors and drills.
These activities shall utilize labor from neighborhood to supplement some machinery works such as that by the concrete mixers, thus creating employment for the local population.

The expected pollutants and wastes that may result from the above mentioned activities of the two components during this phase are the followings:

- Dust caused by earthworks using heavy equipment and trolley;
- Gases Emissions (fossil fuel charged equipment and Vehicles);
- Noise generated from the heavy equipment and machinery;
- Solid and Liquid wastes;
- Increased traffic Load;
- Accidents.

Operation and Maintenance Phase

This phase is considered the main project's phase during which the electricity will be generated and dispatched to the Al Hasan Electric substation. The activities of this phase are considered the most important ones in the project as they are continuous activities over the lifetime of the proposed project and will have impacts on in-site and neighboring.

PV Plant

The photovoltaic plant needs a control room to control all process in the plant. The activities of this phase create noise, solid and liquid wastes, oil spillages, work accidents. These activities may impact the occupational health and the biodiversity in the PV plant site.
The needed staff for the operation of the photovoltaic plant includes engineers, technicians, and working labors. The duration of this phase is expected to be 20 years, in which permanent jobs will be created. The total staff for this phase is estimated to be **about 19 person including** low skilled, semi-skilled and skilled employees. The majority of work opportunities associated with the operational phase is likely to be taken up by members from the surrounding villages.

Transmission line

The main activities of this phase will be the followings:
General Maintenance
Waste Management

The expected pollutants and wastes that may result from the above mentioned activities during the operation phase for the two components of the project (PV plant, transmission line) are the following:

- Electromagnetic Fields (EMFs);
- Noise resulting from the project operation and maintenance;
- The physical presence of the project structures;
- Radio interference; and
- Accident events.

Decommissioning phase

This phase includes the following activities in the two project's components:

Demolition and material removal Works
Site Rehabilitation

The expected pollutants and wastes that may result from the above mentioned activities during the construction phase are the following:

- Dust caused by earthworks using heavy equipment and trolley;
- Gases Emissions (fossil fuel charged equipment and Vehicles);
- Noise generated from the heavy equipment and machinery;
- Solid and Liquid wastes;
- Increased traffic Load; and
- Accidents

The requirements of this phase are Jack Hummer, Loader and large trucks for material transporter; this phase needs **60 people** for a very short period.

Approach and Methodology

The approach to this study was prepared such as to be in compliance with all the requirements of IFC and Ministry of Environment. It involves understanding of the proposed project components, their preliminary design and implementation plan and operation phase of each component.
Baseline studies were conducted through site investigation in the project area and data review, public consultation through scoping session, community consultation and focus group meetings, field survey and photography.

The methodology used for conducting EIA comprises the following.

- Environmental screening; screening of the project was undertaken to evaluate the need to conducting an EIA study and the level of the study.
- Environmental Scoping; the project scoping stage was followed by screening stage , and was applied to narrow down the project issues that requiring detailed analysis, the process involved conducting discussions with the project owner on the project issues and collection of primary and secondary data.
- Desk study; desktop studies were conducted through the view of secondary data to establish the following:
    - Legal policies
    - Legislative and institutional framework governing the project
    - Licenses and permits requirements and conditions
    - Project area baseline information, including documented sensitive environmental receptors, types of wastes to be generated, proposed management and disposal methods and potential positive impacts.
- Field assessment and baseline survey; detailed field survey for this study involved conducting systematic field traversing to quantify perceived undertaken within the proposed project areas and its surrounding from impacts on vegetation cover of the area, ground and surface water, waste management and the general environment and its sensitive receptors.

The EIA study team traverses the whole project areas and identified the status of the environment and the socio-economic indicators which include the followings:

- The baseline data on biophysical environment with concentration on the ecology of the project areas;
- Socio-economic and cultural environment;
- Project affected persons (where applicable);
- the level of project impacts on affected persons and the environment;
- The alternative routes of the proposed transmission line, and
- Stakeholder consultation; through land owners interview, community consultation, public scoping session, and focus group meetings at Husha and Buwaida areas.

Baseline environmental status for the two components of the project

Certain reliable baseline data currently exists on the natural environment of the PV plant and the TL route areas, including air environment, i.e climatology and meteorology, terrestrial environment, i.e geology, geomorphology; ecology and biotic resources; Water resources, resources use (land use, etc.); archeological resources, and socio-economic conditions. To update and provide complete coverage of the available database, the study team undertakes a literature and information search based on personal contacts with appropriate government agencies and other sources.

Based on review of all available information, a description of environmental setting is prepared, including the two components of the project site areas description; the atmosphere environment (climate attributes); the terrestrial environment (geology, physiographic, vegetation, biodiversity species of special concern); water resources; land use (residential, agricultural, commercial, etc); accessibility to existing services; archeology and heritage resources and socio–economic and demography characteristics (population, local interest group, social and community services/ infrastructure, industrial base, retail and commercial services.

Anticipated Potential Impacts

The outcomes of the project activities could be divided into environmental aspects and environmental impacts. The aspects are defined as any element of an organization's activities, products or services that can interact with the environment and the environmental impact could be defined as any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.

The aspects which are generated from the above activities may lead to one or more impacts while many aspects may share the same impact.

Assessment of Issues

The study team considered direct, indirect, and residual environmental impacts associated with the development of the proposed project components (PV and TL) in Husha and Buwaida areas. Issues were assessed in terms of the following criteria:

- The **nature**, a description of what causes the effect, what will be affected, and how it will be affected;
- The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development), regional or national;
- The **duration**;
- The **magnitude**,
- The **probability of occurrence**,
- The **significance**, which is determined through a synthesis of the characteristics described above
- The **status**, which is described as either positive, negative or neutral;
- The degree to which the impact can be reversed;
- The degree to which the impact can be mitigated

As the developer JSO has the responsibility to avoid or minimize impacts and plan for their management, the mitigation of significant impacts is discussed. Assessment of impacts with mitigation is made in order to demonstrate the effectiveness of the proposed mitigation measures.

A summary of the findings of the assessment undertaken for potential impacts associated with the construction and operation of the two components of the proposed project on project area is provided. Issues were assessed in terms of the criteria detailed above. The nature of the potential impact is discussed; and the significance is calculated with and without the implementation of mitigation measures. Recommendations are made regarding mitigation/enhancement and management measures for potentially significant impacts and the possibility of residual impacts are noted.

Potential Impacts on biodiversity

The most important expected negative impacts of this project will be due to loss of habitats which may have direct or indirect impacts on the individual species. Potential impacts on the biodiversity are summarized below.

- **Impacts on vegetation**

Residual Impacts: The development requires that all the woody vegetation within the development footprint is cleared, which cannot be avoided or fully mitigated.

- **Increased alien plant invasion**

Residual impacts: If alien species at the site are controlled, then there will be very little residual impact

- **Increased erosion risk as a result of soil disturbance and loss of vegetation cover**

Residual Impacts: If erosion at the site is controlled, then there will be no residual impact

- **Disturbance, transformation and loss of habitat will have a negative effect on resident fauna**.

Residual Impacts: Some habitat loss is an inevitable consequence of the development and cannot be fully mitigated.

- **Birds Impacts**

Residual Impacts: The large change in vegetation structure resulting from the development would amount to long-term habitat loss for most species

- **Fragmentation of landscape**

Residual Impacts: The change in vegetation structure will be permanent and for those species which require such habitat, mitigation will not be possible. If a ground layer of grass and shrubs can be maintained within parts of the plant, many smaller species will benefit and the residual impact on such species will be low.

Potential Impacts on soils and agricultural potential

The activities of the proposed project components (PV and TL) may have potential negative direct impacts in terms of soil loosening, erosion, compaction, and contamination in addition to the agricultural potential. These activities may also cause indirect impacts such as dust emission generated from the site.

However, we could say that the project implementation phases may have potential impacts which are likely to be insignificant on the soil and agricultural potential.
It's worth mentioning that the livestock of the PV plant neighboring communities that used to graze in the project area for a very short period during spring time will have minor loss of grazing land while the proposed project is being developed.

Moreover, the project will help mitigate the overgrazing and urbanization issue within the site of PV plant. The project will be off limit to grazing animals and any building activities or housing developments will be restricted since this site is reserved for the purpose of the project usage for the next 20 years and possibly for another 20 years, as a second term. Total will be 50 years from the time this project is constructed. The PV plant constituent are all made of inert material which won't introduce any harmful materials into the surrounding environment and in fact may provide safe and secure environment for wild birds on their way to the more desirable areas with water and vegetation about 20-50 KM away from the project site.

Potential impacts on archaeological sites

As the proposed project (PV and TL) area is void of archaeological sites as mentioned earlier in the baseline study of this report. No impacts from the activities of the project development phases are expected

Potential visual impacts

The sensitive receptors in the foreground and middle ground of the generated view shed represent Mafraq main road and Husha road.
The proposed project will present a change in land use and land form to the current status of the project site. The introduction of the foreign structures and forms may have a potentially significant impact on sensitive receptors

The landscape through which the proposed line passes is rather a flat plain and a part of Irbid-Mafraq plains. The landscape of the part of the line that will be in the ROW of Mafraq-Irbid national road is flat as well as the part that passes through the urban areas of Buwaida.

However, it's concluded that no significant impact on these landscape character. The route of the transmission line generally follows the lower ground, so, the influence on the landscape character would be local and quiet limited.

Assessment of Potential Social Impacts

Impacts associated with the construction phase of a project are usually of a short duration (18 months) temporary in nature, but could have long term effects on the surrounding environment. The operational life of the project is 20 years, after which the plant would possibly be upgraded to continue its lifespan if feasible, or decommissioned. The impacts usually associated with the operational phase are therefore perceived by affected parties to be more severe.

Social Impacts associated with the Construction Phase

Potential positive impacts

- Creation of employment and business opportunities and opportunity for skills development and on-site training

Potential negative impacts

- Impacts associated with the presence of construction workers on site;
- Increased risk of stock theft, poaching associated with presence of construction workers on the site;
- Threat to safety and security of farmers associated with the presence of construction workers on site;
- Impact of heavy vehicles, including damage to roads, safety, noise and dust;
- Potential loss of grazing land associated with construction-related activities.

Social Impacts Associated With the Operational Phase

The key social issues affecting the operational phase include:

Potential positive impacts

- Creation of employment and business opportunities. The operational phase will also create opportunities for skills development and training;
- Benefits associated with the establishment of a community trust;
- The establishment of renewable energy infrastructure; and
- Increasing the power transmission capacity to the AlHasan substation.

Potential negative impacts

- The visual impacts and associated impact on sense of place;

Social Impacts Associated With the Decommissioning Phase

The social impacts associated with final decommissioned project are likely to be limited due to the relatively small number of permanent employees (29) affected. The potential impacts associated with the decommissioning phase can also be effectively managed with the implementation of a retrenchment and downscaling program. With mitigation, the impacts are assessed to be Low (negative).

The decommissioning phase will also involve the disassembly of the proposed project components and rehabilitation of the sites. The decommissioning phase will therefore also create additional, construction type jobs. Based on experience on other solar projects ~60 people will be employed during the decommissioning phase.

Assessment of the Do Nothing Alternative

The 'Do-Nothing' alternative is the option of not constructing the proposed PV plant project. Should this alternative be selected, the predicted environmental impacts will not result. However, the local and regional socio-economic and environmental benefits of this renewable energy facility will not be realized. These benefits include:

- Increased energy security
- Exploitation of our significant renewable energy resource
- Pollution reduction
- Climate friendly development
- Support for international agreements
- Employment creation
- Acceptability to society

The No-Development option would represent a lost opportunity for Jordan to supplement its current energy needs with clean, renewable energy. However, as indicated above, the overall contribution of the two components of the proposed project in Husha and Buwaida to Jordan's total energy requirements will be relatively small. In addition, the current application is not unique. The potential contribution of the proposed project should therefore be regarded as valuable, but should not be over-estimated.

The No-Development option would also result in a loss in employment opportunities associated with both the construction and operational phase. In addition, the benefits for the local community in the area associated with the establishment of a Community Trust funded by revenue generated from the sale of energy from the proposed project would be forfeited. The revenue from the proposed project can be used to support a number of social and economic initiatives in the area. These benefits would be forgone if the proposed project is not developed. Given the limited economic opportunities in the area this would represent a negative social cost for the local community.

Environmental and Social Management Plan (ESMP)

The consultant developed an environmental management plan for the proposed project (PV and TL) to guide the project teams in managing the environmental and social situation in the project components and project areas in order to eliminate or reduce the project impacts to acceptable minimum national and international standards.

The EMP provides a general outlay of the environmental and social potential impacts, mitigation measures, monitoring means and frequency and responsibility for monitoring. The responsibility for incorporation of mitigation measures for the proposed on project implementation lies with **JSO** and **the EPC contractor**. The EMP is provided in a separate document and includes the following main components:

- Mitigation measures to reduce or eliminate the negative impacts to acceptable levels;
- Monitoring program for the important environmental parameters;
- Capacity building and training needs for the project labours and personnel;
- Health and safety concerns of the proposed project; and
- Stakeholder engagement plan.

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ABBREVIATIONS

AC	Alternating Current
AES	Amman East power plant
AHP	Al Hasa Phosphorite
DC	Direct Current
DD	Drawdown
DOS	Department of Statistics
DWL	Dynamic Water Level
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPL	Environmental Protection Law
EPC	Engineering, Procurement and Construction
ERC	Electricity Regulatory Commission
GPS	Global Positioning System
HSG	Hydrological Soil Group
IBAs	Important Bird Areas
IDECO	Irbid Distribution Electrical Company
I &APs	Interested and Affected Peoples
JADIS	Jordan Antiquities Database and Information System
JISM	Jordan Institute for Standards and Metrology
JN	Jordanian North grid
JS	Jordanian Standard
JSO	Jordan Solar One
JVA	Jordan Valley Authority
JEPCO	Jordan Electric Power Company

Km	Kilometer
m/s	Meter per second – wind velocity
MCM	Million Cubic Meter
MEMR	Ministry of Energy And Mineral Resources
MOA	Ministry of Agriculture
MOH	Ministry of Health
MOMA	Ministry of Municipal Affairs
MOTA	Ministry of Tourism And Antiquities
MPWH	Ministry of Public Works And Housing
MSL	Meter above sea level
MW	Mega Watt
MWI	Ministry Of Water and Irrigation
N.A	Not Available
NEPCO	National Electricity Power Company
NRCSCN	Natural Resources Conservation Services Curve Number Approach
PGE	Palestinian Grid East
PGN	Palestinian Grid North
Ppm	Part per million
PV	Photovoltaic
REEE	Renewable Energy and Energy Efficiency
SWL	Static Water Level
TL	Transmission Line
TOR	Terms of Reference
WAJ	Water Authority of Jordan
WMO	World Metrological Organization

GLOSSARY of TERMS

Biogeographical zone	The broadest biogiographic division of the Earth's land surface, based on distributional patterns of terrestrial organisms
Capita	A Latin prepositional phrase "by heads" or "for each head", i.e. per individual/person. The term is used in a wide variety of social sciences and statistical research contexts, including government statistics, economic indicators, and built environment studies
Client	Jordan Solar One
Dunum	A unit of land area used in the Ottoman Empire and representing the amount of land that can be plowed in a day. The unit is still in use in many areas now, and is equivalent to 1000 m^2
Dust	Solid particulate matter that can become airborne
Energy	One of the basic quantitative properties describing a physical system or object's state. Energy can be transformed (converted) among a number of forms that may each manifest and be measurable in differing ways
Environment Consultant	Al Shamil Engineering
Environmental assessment	An environmental analysis to determine whether site / facility would significantly affect the environment , something called an environmental impact statement or assessment
Environmental effect	A change in environmental conditions resulting from an action or development, which may be negative, positive, or neutral
Environmental protection law	Jordanian Environmental Protection Law No. 52 Of 2006, which emphasizes on the protection of the components and Elements of the Environment and improvement of same and prevention of the deterioration or pollution thereof or the reduction thereof to within the safe pollution thresholds, and these components include the air, the water, the soil, natural beings and Man, and the resources thereof

Exceedance	A measured level of pollutant higher than the appropriate ambient quality standards
Exposure	The concentration of the pollutant in the air multiplied by the population exposed to that concentration over a specified time period
Facility	Photovoltaic plant
Fauna	Is all of the animal life of any particular region or time
Flora	is the plant life occurring in a particular region or time, generally the naturally occurring or indigenous—native plant life
Ground water	Water beneath the earth's surface , accumulating as a result of infiltration and seepage, and serving as a source of springs and wells
Hydrogeology	The science of chemistry and movement of ground water
Hydrology	The science encompassing the behavior of water as it occurs in the atmosphere on the surface of the ground , and under ground
Impact	The effect or impression of one thing on another. And here, environmental impact
Liquid Waste	Includes industrial wastes such as oil and natural gas refinery byproducts, municipal waste, and chemical byproducts
Mean	Arithmetic average
Modeling	Using mathematical principles, information is arranged in a computer program to model conditions in the environment and to predict the outcome of certain operations
Monitoring	The periodic or continuous sampling and analysis of air pollutants in ambient air or from individual pollution sources
Municipal Solid Waste	Commonly known as trash or garbage, consisting of everyday items we consume and discard. It predominantly includes food wastes, yard wastes, containers and product packaging, and other miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources

Noise	Any unwanted sound. And noise pollution is defined as the disturbing or excessive noise that may harm the activity or balance of human or animal life
Nomadic	People who move from one place to another, instead of than living in one place
Particulate matter	Any material, except pure water, that exists in the solid or liquid state in the atmosphere. the size of particulate matter can vary from coarse , wind – blown dust particles to fine particle combustion products
Photovoltaic	is the field of technology and research related to the devices which directly convert sunlight into electricity
Precipitation	As used in hydrology, precipitation in the discharge of water, in liquid or solid state, out of the atmosphere, generally upon a land or water surface. it is the common process by which atmospheric water becomes surface or subsurface water
Proposed Project	The Photovoltaic plant and the Transmission line
Receptor	A human or ecological entity exposed to a contaminant released to the environment
Renewable energy	A socially and politically defined category of energy sources. Renewable energy is generally defined as energy that comes from resources which are continually replenished on a human timescale such as sunlight, wind, rain, tides, waves and geothermal heat
Renewable energy strategy	The National Energy Strategy for 2007-2020 was created which projects within the next decade to boost reliance on domestic energy sources from 4 per cent to 40 per cent by the end of the decade
Risk	A measure of the probability that damage to life, health, property, and / or the environment will occur as a result of a given hazard
Risk management	An evaluation of the need for and feasibility of reducing risk. it includes consideration of magnitude of risk, available control technologies economic feasibility

Salinity	The saltiness or dissolved salt content of a body of water . Salinity is an important factor in determining many aspects of the chemistry of natural waters and of biological processes within it, and is a thermodynamic state variable that, along with temperature and pressure, governs physical characteristics like the density and heat capacity of the water
Socio – economic analysis	An analysis of the effects of a project on a group or area. socio – economic analysis is a subset of economic analysis
Solar Panel	Large group of semiconductor technology based silicon solar cells arranged in what is known as solar PV panel or solar module, solar panels convert impinging sun rays (photons) to electrons
Solar power	is the conversion of sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP)
Source	Any place or object from which air pollutants are released. sources that are fixed in space are stationary source and sources that move are mobile source
Stakeholders	Citizens , environmentalists , businesses , and government representatives that have a stake or concern about how air quality is managed
Standards and Regulations	The Jordanian Standards and Regulations related to the proposed project

1. Introduction

1.1 Status of Power Sector in Jordan

1.1.1 Jordan Electricity Market

Electricity production in Jordan has steadily increased during the past ten years to meet growing power demands; these high growth rates are expected to continue for the next 10 to 15 years. Electricity consumption in Jordan reached 12.84 terawatt-hours (TWh) in 2010, growing on average 8.1 percent per annum from 6.9 TWh in 2002. The average distribution loss has risen from 10.9 percent in 2004 to about 12.12 percent in 2010. This loss is partially offset by improvement in transmission loss, which has declined from 3.7 percent in 2004 to 2.1 percent in 2010.

Jordan is almost entirely dependent on fuel imports to meet its energy requirements (over 95 percent dependence). The value of fuel imports amounted to 12 percent of GDP. As part of a decade-long structural reform of its economy, Jordan has sought to diversify its fuel mix and supply sources in order to reduce dependence on imports and the use of oil. For electricity generation, the Government in 2004 signed a thirty-year gas import contract with Egypt. Jordan is also taking some concrete steps to develop its renewable energy resources.

By 2010, Jordan had about 3,205 MW of installed electricity generation capacity, of which just 17 MW is contributed by renewable energy, with the rest running on natural gas, heavy fuel oil, and diesel. According to a recently prepared sector investment Master Plan, the interconnected system currently operates with very low reserve capacity if electricity imports are excluded. The peak demand in 2010 was 2,650 MW, while the existing available generation capacity at the time of peak demand of 2010 was about 2,540 MW, which is rather extremely below the required level of available capacity. In order to meet the peak demand, Jordan imports electricity from Egypt, whose power system is also under stress. The deficit in the domestic generation capacity is projected to increase to about 300 MW in 2012 (peak demand of 3,078 MW versus available capacity of about 3,205 MW) in order to keep a planning reserve of 10-14%. For this reason, the Government has already initiated acquisition of additional generation capacity.

By 2010, more than 98 percent of the electricity supply to the interconnected system was locally generated with the imported fuel from outside the country.

1.1.2 Institutional and Regulatory Framework of the Jordan Electricity Sector

Jordan was one of the first countries in the region to initiate fundamental reforms in the electricity sector and has made significant progress in carrying out the reform.

Until the year 1996, the national power utility was the Jordan Electricity Authority (JEA), created in 1967. It was the integrated monopoly in charge of generation, transmission and distribution.

As a part of its broad reform policy, the Government of Jordan has taken a number of decisions in the energy sector aimed at encouraging competition and private sector participation, particularly in the generation and distribution of electricity. In 1999, the power sector was completely unbundled. The electricity system in Jordan is now divided according to activities into three categories:

- Generation represented by Central Electricity Generation Company (CEGCO), Samra Electric Power Generation Company (SEPGCO) and AES Jordan;
- Transmission through high-voltage lines which is done by NEPCO, which is also responsible of the interconnection with Egypt and Syria, and the operation of the electric system;
- Distribution of electricity through medium and low voltage lines to supply end consumers which is done by Jordan Electric Power Company (JEPCO), Irbid Distribution Electrical Company (IDECO) and EDCO, each in different regions of Jordan.

The electricity sector in Jordan is governed by the General Electricity Law (Temporary Law No. (64) for the Year 2002), which empowers the Ministry of Energy and Mineral Resources (MEMR) to establish policies and general rules for the power sector. This law creates an independent Electricity Regulatory Commission (ERC) to protect the interest of consumers and investors, approve tariffs, and grant licenses for generation and distribution of electricity, including tariffs for independent power producers. Electricity tariffs are largely cost reflective with some cross-subsidies embedded in the tariff structure.

The government has since prepared a draft “unified” energy law, which covers the power sector (by including the existing General Electricity Law), the oil and gas sector, and renewable energy (by including the Renewable Energy Promotion Law). The draft energy law proposes to establish a single energy regulatory agency for the electricity and oil and gas sectors, which would subsume the existing ERC.

In order to promote and facilitate investments in renewable energy and energy efficiency, revised renewable energy legislations included under the draft Energy Law have been approved by the new Government under a separate Renewable Energy and Energy Efficiency (REEE) Law. The new REEE law was also approved by the Royal Court and became effective in February 2010. With this recent approval of the REEE, the Government of Jordan has taken an important step towards achieving its ambitious 10 percent-target for renewable energies in the total energy mix by 2020. In the electricity sector, this could translate into a RE capacity of 1,600 MW of which 600 MW is targeted from solar in the total generation mix by 2020.

The National Electric Power Company (NEPCO) is licensed by the ERC, in accordance with the Electricity Law No. 64/2002, to be responsible for the electric power transmission at 400 & 132 kV voltages and supervising and dispatching the electric energy from the different generating units to the bulk-supply points for the electric energy distribution companies in Jordan and some large industrial consumers.

NEPCO sold electricity to 16 customers in 2010:

- 13 direct end-use customers, mostly industrial companies, representing 5.2% of total NEPCO sales;
- The 3 distribution companies, representing 94.4% of NEPCO's sales. The rest of sales are exported to Egypt and Syria.

NEPCO is responsible for the design, construction, and the safe operation of the National Transmission Grid, in addition to the trading in electric energy utilizing the Single Buyer Model, buying it from different suppliers, inside Jordan, and abroad through the 400 kV tie lines with Egypt and Syria. The whole electric power system in Jordan is operated through the National Control Centre in Amman.

NEPCO is assigned to administer natural gas imports from Egypt, to be utilized to supply the different power stations in stages, starting from ATPS and to Al Samra and Rehab Power Stations besides the new IPP's power plants.

1.2 Background

JSO intends to develop a PV Plant with maximum export capacity of 20 MWac in Husha area in Mafraq Governorate and to establish a transmission line of 33 kv between the PV plant and the Al Hasan electric substation (132/33 kv) in Ramtha district of Irbid Governorate which is located at a distance of 13 km north west of the PV plant.

The PV plant site is located near Husha Village of Mafraq Governorate. The plant will span over a number of land parcels, including parcels **No. 133,132,20,23, 91, 70, 92, 93, 89, 62, 125, 113** from Altnaib lands of **Husha village**. The total surface area of the proposed project site is estimated at about **1,400,000 m^2 or 1400 Donums**. While the proposed transmission line is expected to traverse lands of about 12 km of Husha area of Mafraq governorate and Buwaida area of Irbid Governorate, these lands are under different land uses. The transmission line will totally traverse areas of public lands, where there are varieties of land uses all along the line including sparsely and populated residential areas along the line; it is anticipated to the most likely negative impacts.

The proposed project will have cost such as to include land leasing, professional services, operation, the licenses and permits, and construction.

To meet the Jordanian environmental regulations, in particular, The Environmental Impact Assessment By Law No.37/2005 under the environmental protection law No.52/2006, and **IFC's** applicable requirements, **JSO** has to prepare an Environmental Impact Assessment (EIA) study for the above said project through a qualified consulting firm specialized in conducting environmental studies. To conduct this study, JSO selected Al-Shamil Engineering to conduct the study according to the regulations and the requirements of the ministry of the Environment and IFC.

The EIA study will be carried out in order to ensure that significant impacts in the environment are taken into consideration at the construction, operation and maintenance, and decommissioning phases of the two components of the proposed project.

The goal of this assignment is to ensure that any potentially adverse environmental and social impacts can be minimized to the extent feasible, and the positive impacts can be enhanced.

The Re-settlement Action Plan (RAP) if it's applicable exercise, on the other hand, will set out a framework for policies and principles to facilitate any resettlement process that will be necessitated as a result of the proposed project.

The Environmental receptors expected within the project area include the biodiversity, occupational and public health, and natural resources in addition to the socio-economic condition.

1.3 Project Objectives

The overall objective of the project is to support the rationale and sustainable use of alternative energy resources in Jordan. However, the objectives of this project are as follows:

- Establish a photovoltaic (PV) plant at the proposed site, which is located at Husha area and to connect it to the national electricity grid in the northern part of Jordan through construction and operation of a transmission line of 33 Kv for a distance of about 13 km.
- Develop awareness and capacity building to demonstrate and promote the reliability and potentials of the selected PV plant.
- Contribute to the implementation of the Jordanian renewable Energy Strategy.
- Boost interest of private sector in renewable energy technologies.
- Establish an educational fund to provide scholarships for the disadvantaged students from the local community.

In addition to the energy produced by the photovoltaic plant, the proposed project has the added advantage of income generation through the sale of the electricity produced. As the proposed project is located in the northern part of the country it will feed the national grid and also promote grid support and may result in a more secure energy supply for energy users in the local area, as a generating facility increases the locality's priority distribution network and therefore potentially reduces the risks of future load shedding in the area.

1.4 Environmental Impact Assessment

Definition

The environmental Impact Assessment EIA is a preventive protection measure which is based on the development of a study consultations with participation of the public and analysis of alternative measures, for the purpose of collecting data and foreseeing adverse effects of specific projects on the life and health of humans, on flora and fauna, on land, water, air, climate and landscape, on material and cultural goods and the interaction of these factors, as well as, for the purpose of establishing and proposing measures for prevention, mitigation or remediation of harmful effects, taking into consideration the feasibility of these projects.

Need

Impact assessment is required for projects in the planning or implementation phase, changes in technology, reconstruction, expansion of capacities, decommissioning and removal of projects that can have significant impacts on environment as well as for projects that have been realized with no prior environmental impact assessment which do not have a building permit.

The EIA process usually comes in two phases, these phases are: **Phase One: Initial Inquiries (PEA) and Phase Two: Full EIA (Comprehensive EIA).**

Phase One comprises: (1) Understand the activities, all EIA processes begin with understanding what is being proposed and why?, (2) Screening the activities: based on the nature of the activity and what level of environmental review is indicated, the activity will be screened; This means the screening classifies the activity into a risk category, which are: (a) Very low risk leads to end EIA process. (b) Moderate and unknown risk leads to conducting preliminary EIA, and (c) Very high risk leads to conduct a full or Comprehensive EIA study. The outcome of the screening process determines the next step in the EIA process.

Phase two; Full EIA study, if phase one indicates that a full EIA study is required, we have to proceed to phase two of the EIA process. The full EIA study has very similar objectives and structures to a preliminary assessment. For this assignment, a full EIA (comprehensive) is needed. However, the full EIA study differs in important ways:

- A formal scoping process precedes the study to identify issues to be addressed;
- Analysis of environmental impact is much more detailed;
- Alternatives must be formally defined;
- The impacts of each alternative must be identified and evaluated and the results compared;
- Public participation is usually required; and
- A professional EIA team is usually required.

The basic Steps of the full EIA study are:

- Scoping
- Evaluating baseline situation
- Identifying and choose alternatives
- Identifying and characterizing potential impacts of proposed activity and each alternative
- Comparing alternatives
- Developing mitigation and monitoring

The full EIA study is a far more significant effort than the preliminary assessment. It's reserved for activities for which screening of preliminary assessment shows that significant impacts are likely.

2. Legislative and Regulatory Consideration

2.1 Introduction

The proposed project with its two components (PV plant and the TL) must comply with several local laws, bylaws, regulations and standards, as well as pertinent international standards. Thus, Al Shamil Engineering team shall provide a brief summary of the pertinent regulations and standards governing environmental quality, health and safety, protection of sensitive areas, siting, land use control, etc… at national, regional, international , and local levels. Some of the regulatory authorities have jurisdiction over this project. These authorities include but are not limited to Ministry of Environment, Ministry of Public Health, Ministry of Water and Irrigation, Ministry of Public Works and Housing, and general civil directorate. This study considers both national and international legislations.

2.2 National Environmental Legislations and institutional Framework

An initial list of national environmental and health safety legislations relevant to the proposed project in the construction, operation and decommissioning phases is shown in table (2.2.1).

Table 2.2.1: The initial list of national environmental and health safety legislations relevant to the proposed project

Legislation	Environmental issues						
	Air quality	Water quality	Waste disposal	Noise	Land use	Nature conservation	Cultural heritage
Environmental Protection Law No. 52/2006							
Environmental Impact Assessment bylaw No. 37/2005	X	X	X	X	X	X	X
Protection of Environment Due to Emergency Cases No.26/2005	X	X	X	X	X	X	X
Management, Transportation, and Handling of Hazardous Materials, No.24, Year 2005			X				
Protection of Air, No.28/ 2005	X						
Management of Solid Waste, No. 27/ 2005s		X	X				
Instructions of "Management of Waste Oils"			X				
Guidelines for the management and handling of exhausted oils for the year 2003		X	X			X	
Guidelines for control and prevention of noise for the year 2003	X	X	X	X			X
Protection of Soil, No.25/ 2005					X		
Jordanian Standard for ambient air quality No. 1140/2006	X						
Maximum allowable limits of air pollutant emitted from stationary sources No. 1189/2006	X						
Law of renewable energy and energy efficiency for the year 2011	X	X					
Guidelines of the cost of connecting the renewable energy plant to the distribution systems, 2012							
Penal law No. 16 for the year 1986	X	X	X	X			

Legislation	Environmental issues						
	Air quality	Water quality	Waste disposal	Noise	Land use	Nature conservation	Cultural heritage
Public health law No. 47 for the year 2008	X	X	X	X			
Guidelines for the prevention of health harms related to health damage caused by residential units and labor gatherings No. 1/2011 based on Public Health Law	X	X	X	X			
Guidelines for medical waste 1 /2001	X	X	X	X			
Labor law and its amendments No. 8 /1996							
Minister's decision related to medical emergency devices for labors in the establishments based on the authorities to the Minister under clause (4), paragraph (a) of Article (78) of the Labor Law No. (8/1996			X				
Instructions of Workers and working environment protection due to occupational hazards, Year 1998"			X				
The law of Agricultural No. 44 for the year 2002		X			X	X	
Forest and Soil preservation law No. 71/ 1971						X	
General electricity law no .64 for the year 2002							
Regulation of organizing and management of the ministry of energy and mineral resources no. 26 for the year 1985					X		
Civil defense law No. 90 for the year 2003			X	X		X	
Municipality law No. 54 for the year 2007							
Traffic law No. 49 for the year 2008	X			X			
City and village and building control law No. 79 for the year 66		X	X	X	X		
Architectural and cultural heritage law No.5 for the year 2005			X	X	X		X

Legislation	Environmental issues						
	Air quality	Water quality	Waste disposal	Noise	Land use	Nature conservation	Cultural heritage
Water authority law No .18 for the year 1988 and its amendment		X			X		
Jordanian standard for reclaimed domestic waste water No. 893 for the year 2001 and the proposed law for the year 2006	X	X	X				
Jordan water strategy for year 2009		X					
Ground water control bylaw No.85 for the year 2002		X					
Regulations for protection of birds and wildlife and rules governing the hunting No. 113 for the year 1973					X	X	
Acquisition law No. 12 , year 1987					X		
Law of transport No. 89/2008				X			
Law of craft and industries No.16 for the year 1953 and its amendment	X	X	X				
Management of natural resources law No.12 for the year 1968							X

Following is a brief summary of the pertinent regulations governing the environmental impact assessment studies at national and local levels.

Environmental Impact Assessment By-law No.37, Year2005

This by-law lies under the environmental protection law no 52/ 2006 and divides the EIA studies to a comprehensive and preliminary environmental studies based on the type and size of a project. This by-law has 5 Appendices; Appendices 1-2 list the criteria for a project that will require a full EIA. While Appendices 3-4 list the criteria for a project that require a preliminary study. The fifth Appendix lists the contents of the EIA report. The preparation of the EIA study follows Articles 8-12 which provide the steps needed for this work.

Environmental Regulations

These regulations lie under the environmental protection law no 52/ 2006 and should be followed and respected by the project owner and management. These regulations include the following:

- Protection of Air, No.28, 2005 listed. In this regulation, Articles 3, 4, 6, and 9-14, list the responsibilities and requirements of any establishment to protect air environment.
- Protection of Environment Due to Emergency Cases No.26, Year 2005; in Sub-Article 25-A-2 of the law. In this regulation Articles 9-12, list the responsibilities of any industrial establishment in case of an emergency.
- Management, Transportation, and Handling of Hazardous Materials, No.24, Year 2005 in Sub- Article 25-A-Y. In this regulation; Articles 6, 7, 8, and 10 list the prohibition, permissions, and requirements of managing and handling hazardous materials during operations and transportation.
- Instructions of "Management of Waste Oils". The proponent should comply particularly with Articles 4, 5, and E5 which are related to the general conditions of circulating usage, discharging waste oils, and how to gather, store, and transport oils.
- Management of Solid Waste, No. 27, Year 2005, listed in Su-Article 25-A-8, lists in Article5, the requirement for any establishment producing solid waste to provide sufficient personnel and equipment to properly collect, manage, and dispose solid waste.
- Environmental Impact Assessment, listed in Sub-Article 25-A9. (mentioned above)
- Protection of Soil, No.25, Year 2005, listed in Sub-Article 25-A-10, lists in Article 6, the requirement of any industrial establishment to provide sufficient protection to soil due to any industrial dust or any industrial residues that will need treatment.

Pollution Control

Any industrial activity that has an adverse impact on the environment will have to provide sufficient control equipment or procedures to alleviate such impacts.

Instructions for the Prevention and Protection from Noise of the year 2003

These instructions list prohibited noisy actions such as those listed in Article 5 of the document. It states construction operations including heavy machinery to limited operation time between 8 am and 6 pm, except for cases approved by the Minister. Article 6 sets out the allowed limits of maximum noise levels. It sets a maximum of 75 dB(A) during the day and 65 dB(A) during the night in industrial areas. It should be noted that such limits apply to the outside perimeter of working area. Inside the perimeter, the regulations of the Ministry of Labor are applicable.

The Law of Public Health, no 47 Year 2008

Reporting of contagious diseases

This article stipulates the responsibility of the person in charge of any establishment to report any case of contagious diseases to the Ministry and cooperate fully to control such problem.

Reporting any pollution to drinking water resources

This article stipulates the responsibility of any person in charge of any water tank, plant, or filling establishment to report to the Ministry or the Water Authority any case off water pollution.

Reporting of Chemicals Used

This article stipulates the responsibility of any establishment to report its use of any chemicals including its types, characteristics, and quantities.

Responsibility of clean up due to chemicals accidents

This article stipulates the responsibility of anybody causing harm to public health through misuse of any chemicals.

Hygiene Mishaps

It indicates numerous activities which are considered types of hygiene mishap. Stated below some activities relevant to the proposed project:

- Each hazardous or dirty pit or dumping site;
- Each and every material, operation, odor, noise, dust or waste which is classified as hazardous
- Any craft or profession implemented in such a way that could harm the health of the workers and public; and
- Dumping the trash, solid and liquid wastes in public yards and grounds.

Paragraph (b) of Article (49) indicates that dumping of sewage waste in a place other than specified places (sewage pit), as identified by the official -authorities is also considered a hygiene mishap.

Disposal and Treatment of Wastewater

This article stipulates of any establishment to dispose properly and treat if deemed necessary according to the instructions of the Ministry.

The Law of Water Authority, No.18, 1988 and its amendment

Government Land Ownership

This article stipulates the ownership of a 1 km on each side of any water lines or irrigation channels. Any use of such land is considered a violation of the law.

All Water Resources Ownership

This article stipulates the government ownership of any water resources in Jordan. Any use of such resources without proper permission shall be acknowledged as a violation of the law.

Ground Water Control by-lawNo.85/ 2002

This regulation stipulates in Article 3, the ownership of ground water resources to the government. Any use of such resources without the proper permission shall be acknowledged as a violation of such regulation. The required actions in case of accidental resources discovery or pollution of any ground water resource are listed in Articles 15 and 16.

The Law of Labor, No.51, Year 2002

Article 56 states the work hours that should be considered including the right of workers of not to work more than 8 hours a day and Article 73 bans the employment of the under aged.

The law of Agriculture No. 44 for the year 2002

According to the article 32 of this law, the proposed project operations and activities shall not encroach in forest or specified agricultural areas if any of these exists in the project areas.

The general Law of Electricity, No. 64, Year 2002

In Articles 43 c and 45, this law stipulates the responsibilities of each of NEPCO as well as private investor or operator of electric power plants in Jordan.

The Law of Civil Defense, No.90, Year 2503

Firefighting stations

This article stipulates the responsibility of any industrial establishment to install their own firefighting stations.

Hazard prevention and self-protection instructions

Such article stipulates the responsibility of any establishment to implement, any Civil Defense, instructions regarding hazard Prevention and self-protection within its own establishment

The Law of Antiquities, No. 32, Year 2004

Antiquities Ownership

These articles stipulate that the ownership of any antiquities to be vested in the Government of Jordan. Any use or ownership without the proper permission of the government shall be considered a violation of the law.

Listed Antiquities Locations

This article stipulates the authority of the Minister to list the antiquities locations that are under the control of the Ministry, and that any use of such locations without permission of the Minister is a violation of the law.

Prohibition of any heavy industry

This article stipulates prohibition of establishment of any heavy industry within a distance of 1km from any designated antiquity locations.

Traffic law No. 49 for the year 2008

This law has articles that deal with the followings:

- Dimensions, total weights and vehicles' horse power regulation
- Transportation of hazardous material
- Causing hazards on public highways and disposal of wastes on roadways

Law of transport No. 89/2008

This law indicates that ministry of transport will contribute to the protection of the environment in cooperation with relevant authorities and raise the level of public safety awareness during the transport operations.

The Law of Specifications and Metrology No. 22, Year 2000

This law stipulates the compliance with the following standards

- Air Emissions from Stationary Sources, JS. 1891/2006
- Ambient Air Quality, JS.1140/ 2006
- Treated Wastewater Reuse, .JS. 893/ 2002
- Industrial Wastewater, JS 202/2004

2.3 National Institutional Framework (Permitting Agencies)

As a result of the reforms in the environmental sector brought about by the in action of the Environmental Protection Law (EPL), the following governmental agencies became responsible for the environmental sector.

Ministry of Environment (MoEnv)

According the amendments of the environmental sector and the necessity of the environmental impact assessment activation, MoEnv becomes the governmental institution responsible of the environmental affects since 13 of December of the year 2003 according to the environmental protection temporarily law no. 1 for the year 2003.

Under the above mentioned environmental protection law, the MoEnv was established as an autonomous body with manageable and financial independence. The law authorized the MoEnv in coordination with involved regulatory to prepare the general policy for environment protection and explain the necessary strategy for implementation this policy.
The MoEnv must prepare the environmental standards and specifications including dealing with hazardous wastes, and the protected areas in addition to its responsibility to supervise and monitor the industrial community regulatory and others to be sure that they are committed by the by law instructions and the environmental legislations and send the uncommitted parties to the court to have penalties due to their non-commitment.

Other Authorized Agencies

In addition to the MoEnv, other ministries have taken on responsibilities for environmental regulation and the management of environmental affairs. According to the National Environment Action Plan (NEAP), there are currently a total of 18 governmental agencies in 10 ministries active in the environmental field, several of these ministries have created environmental units within their own structures to address the environmental issues that may arise during the implementation of these ministries projects or activities that may have effect on the areas of these projects.
Within this context, the following are the other relevant institutions that have a major contribution in the EIA studies.

Ministry of Energy and Mineral Resources (MEMR)

According to the temporary law of electricity no. 64/2002, the Ministry shall assume the following mandate and powers:

- To set and prepare the general policies of the sector and submit them to the Council of Ministers for approval in accordance with the needs of economic and social development in the Kingdom, and to follow up the development of these policies.
- To co-operate with other countries for the purpose of the electrical interconnection and trade of electric power, as well as to conclude the agreements necessary to that effect with the consent of the Council of Ministers, and to follow up performance of the contractual obligations with those countries.
- To promote the interests of the Kingdom with other countries and regional and international organizations on issues relating to electric power, and to represent the Kingdom before such organizations
- To adopt the necessary measures for the provision of supplemental source of generation of electric power in case of prolonged shortfalls in electric power if no alternative means to overcome the shortfall are available.
- To request the bulk supply licenses, if necessary, to provide fuel for electricity companies set for privatization and licensed for generation, whether before or after their privatization, and for independent power producers.
- To promote the use of renewable energy for generation.
- To recommend to the Council of Ministers to switch to the competitive electricity market pursuant to Article (48) of this Law.

Electricity Regulatory Commission (ERC)

In order to achieve its objectives, the Commission shall have the following powers:

- To license persons engaged in generation, transmission, supply, distribution and system operation.
- To regulate persons engaged in generation, transmission, supply, distribution and system operation in the Kingdom so as to provide reliable electricity service to consumers in an efficient and economic manner those accords with the developments in electricity technology provided taking into account the provisions of Article (5) of this Law.
- To determine the electric tariff, subscription fees, services fees, disbursements, royalties, and the connection charges to the transmission system and distribution system.

- To participate in determining the technical standards relating to the electric appliances and electrical installations, by way of consulting with other concerned parties in order to have such standards issued by the Standards and Meteorology Corporation.
- To participate in determining the necessary requirements for the implementation of the environmental standards to which electrical installations ought to confirm by way of consulting with other concerned parties and to have them issued according to the Legislations in force
- To render expert advice and opinion on any issue that is related to the sector in a way that fulfils the Commission's purposes and objectives.
- To make recommendations to the Ministry to switch from the single buyer model to a competitive electricity market structure in accordance with this Law
- Any other activity or mandate pertaining to the functions of the Commission pursuant to the provisions of the temporary Electricity Law no. 64/2002

National Electricity Power Company (NEPCO)

NEPCO is licensed by the ERC, in accordance with the Electricity Law No. 64/2002, to be responsible for the electric power transmission at 400 & 132 kV voltages and supervising and dispatching the electric energy from the different generating units to the bulk-supply points for the electric energy distribution companies in Jordan and some large industrial consumers.
NEPCO is responsible for the design, construction, and the safe operation of the National Transmission Grid, in addition to the trading in electric energy utilizing the Single Buyer Model, buying it from different suppliers, inside Jordan, and abroad through the 400 kV tie lines with Egypt and Syria. The whole electric power system in Jordan is operated through the National Control Centre in Amman.

Ministry of Water and irrigation (MWI)

This ministry comprises two authorities; Water Authority of Jordan (WAJ) and Jordan Valley Authority (JVA). This ministry with WAJ work together n 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, in addition to studying irrigation patterns and sewerage. Moreover, groundwater, aquifer management and abstraction monitoring and licensing are the responsibility of WAJ.

Ministry of Public Works and Housing (MPWH)

The mandate of the ministry is 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 functionality. 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 Agriculture (MoA)

According to the law of Agriculture No. 44/2002, this ministry is responsible for managing public range lands 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.

Ministry of Health (MoH)

According to the Public health law No.47, year 2008 this ministry is responsible for health affairs by offering preventive, treatment and health control services; organizing and supervising health services offered by the public and private sectors, and many other responsibilities.

Ministry of Municipal Affairs (MoMA)

This Ministry is considered the technical, financial and administrative advisor for all the local councils in the Kingdom. It also supervises the functions of municipal and the joint services councils, to make sure that the work of these councils is in line with the current laws, regulations and instruction.

The Ministry supervises all activities related to the local administrative issues of the municipal councils in terms of providing services and all regulatory issues, as well as the implementation of local development projects, and the coordination of the activities and plans of these councils, to be in line with developmental issues in the entire Kingdom.

Ministry of Tourism and Antiquities (MoTA)

The mandate of this Ministry is to develop tourism in a comprehensive and integrated approach to protect and promote the nation's legacy, culture, history, heritage, inheritance, successive civilizations and economic prosperity. It works to develop an advanced tourism industry capable of utilizing its competitive advantages through highly developed infrastructure facilities and superstructure services.

Jordan Institute for Standards and Metrology (JISM)

JSIM play a leading proactive role in protecting the health and safety of Jordanian citizens and in protecting the environment and to act as a major partner to the private sector in enhancing the quality and competitiveness of Jordanian products, through the development of national standards and guidelines on conformity assessment practices that are harmonized with international ones and through active participation in the work of international standards and conformity assessment procedures, and to facilitate trade with Jordan and pave the way for Jordanian exports to international markets by signing global mutual and multilateral mutual recognition agreements to get international recognition of the Jordanian conformity assessment systems and results.

Ministry of Transport (MoT)

MOT is responsible for tasks 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, as well as 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.

2.4 International and Regulatory Regimes for the Proposed Project

The EIA of the proposed project will be based on internationally respected procedure recommended by the World Bank, covering environmental guidelines. Reference will be made to the:

- IFC Performance Standards (PS) on Environmental and Social Sustainability; which include the followings:

  - Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
  - Performance Standard 2: Labor and Working Conditions
  - Performance Standard 3: Resource Efficiency and Pollution Prevention
  - Performance Standard 4: Community Health, Safety, and Security
  - Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
  - Performance Standard 8: Cultural Heritage

- The World Bank Group's (WBG) Environmental, Health and Safety General Guidelines

International policies, standards, and regulations related to EMF exposure; Average and peak exposure levels should comply with National Institute of Environmental Health Sciences (2002); International Commission on Non-Ionizing Radiation Protection (ICNIRP) (2001); International Agency for Research on Cancer (2002); U.S. National Institute of Health (2002); Advisory Group to the Radiation Protection Board of the UK (2001), and U.S. National Institute of Environmental Health Sciences (1999)). U.S. National Institute of Environmental Health Sciences (2002) ICNIRP is a non-governmental organization formally recognized by the World Health Organization (WHO), which published the "Guidelines for Limiting Exposure to Time-varying Electric, Magnetic, and Electromagnetic Fields "following reviews of all the peer-reviewed scientific literature, including thermal and non-thermal effects. The standards are based on evaluations of biological effects that have been established to have health consequences.

International conventions and protocols related to the project; such as:

- Vienna Convention for the protection of the Ozone layer, 1985
- Montreal Protocol on substances that deplete the Ozone layer, 1987
- The Basel Convention, 1998
- Kyoto Protocol, 1997

3. Project Description

This section provides an overview of the proposed project components, which are the PV plant at Husha area/ Mafraq Governorate and the transmission line that will dispatch the generated electricity to the Al Hasan electric substation. This section also provides a discussion of the main project components and the main activities for construction, operation and decommissioning phases.

In order to have the data needed for the EIA study for the proposed project, the study team met the involved people from Jordan Solar One (JSO) including the technical people of the company and other engineers. In addition, the study team visited the project site and collected all documents related to the proposed project components and requirements and other available data (project design, project location, climatic conditions, etc.).

3.1 Project Location

As mentioned earlier, the proposed project comprises two components, the first component is the photovoltaic plant which is located in north of Jordan/ Husha sub district in Mafraq Governorate at a distance of 80 km from the capital city of Amman, south east of Ramtha city at a distance of 12 km, and north west of Mafraq City at a distance of 12 km, and spans over a number of land parcels of Husha area. The total surface area of the proposed PV plant site is estimated at about 1,400,000 m^2 or 1400 Donums. The land of the PV plant site is rented from the owners (Al Qadi family group) for 25 years according to the rental agreement signed by the two parties.

From the site investigations, layout plan of the land plots and the maps of the area, the PV plant site is recognized by the following features:

- Hamra Village (9500 inhabitants), which is located east of the proposed plant site at a distance of 5 km;
- Husha Village (3000 inhabitants) ,which is located to the north of the proposed photovoltaic plant at a distance of 1.6 km;
- Mesherfeh Village (500 inhabitants), which is located at a distance of about 6 km to the north east of the proposed project site;
- Almansoura Village (3500 inhabitants), which is located to the south east of the proposed plant site at distance of about 6 km;
- Fa`A Village (5000 inhabitants), this village is located at about 2 km to the south west of the proposed site;
- Mafraq –Irbid Road , which is next to the proposed plant site from the west site;
- Al Hassan Substation which located to the north west of the proposed project site at a distance of about 8km,

The proposed PV plant site is a part of almost a flat area extended between Hamra and Husha areas with some hills such as Jabal Altunaib which has an elevation of 729 m above sea level closed to Husha Village, the lowest elevation in the area is about 630 m. The area is intersected by small wadies which have trend towards east and west. The main wadi in the area is wadi Al Zarnouq.

The second component of the project is the transmission line, for which two alternatives were discussed, the selected alternative of the transmission line route will be of overhead type, and will cross over public lands for a distance of about 13 km. this alternative starts from the PV Plant and passes through the ROW of Husha road until its intersection with Mafraq – Irbid national road no.10, then it goes west in the ROW of the national road no.10 for a distance of 5 km The TL then turns south west of the road no.10 through the ROW of planned and approved streets until it reaches the Al Hasan electric substation for the distance of about 8 km.

Figure (3.1.1.a) represents the administrative map of Mafraq Governorate with the location of the PV plant and the route of the transmission line. Figure (3.1.1.b) shows a Google map of the PV plant site and the route of the transmission line, and figure 3.1.2 shows the layout of the land plots where the proposed PV plant will be established.

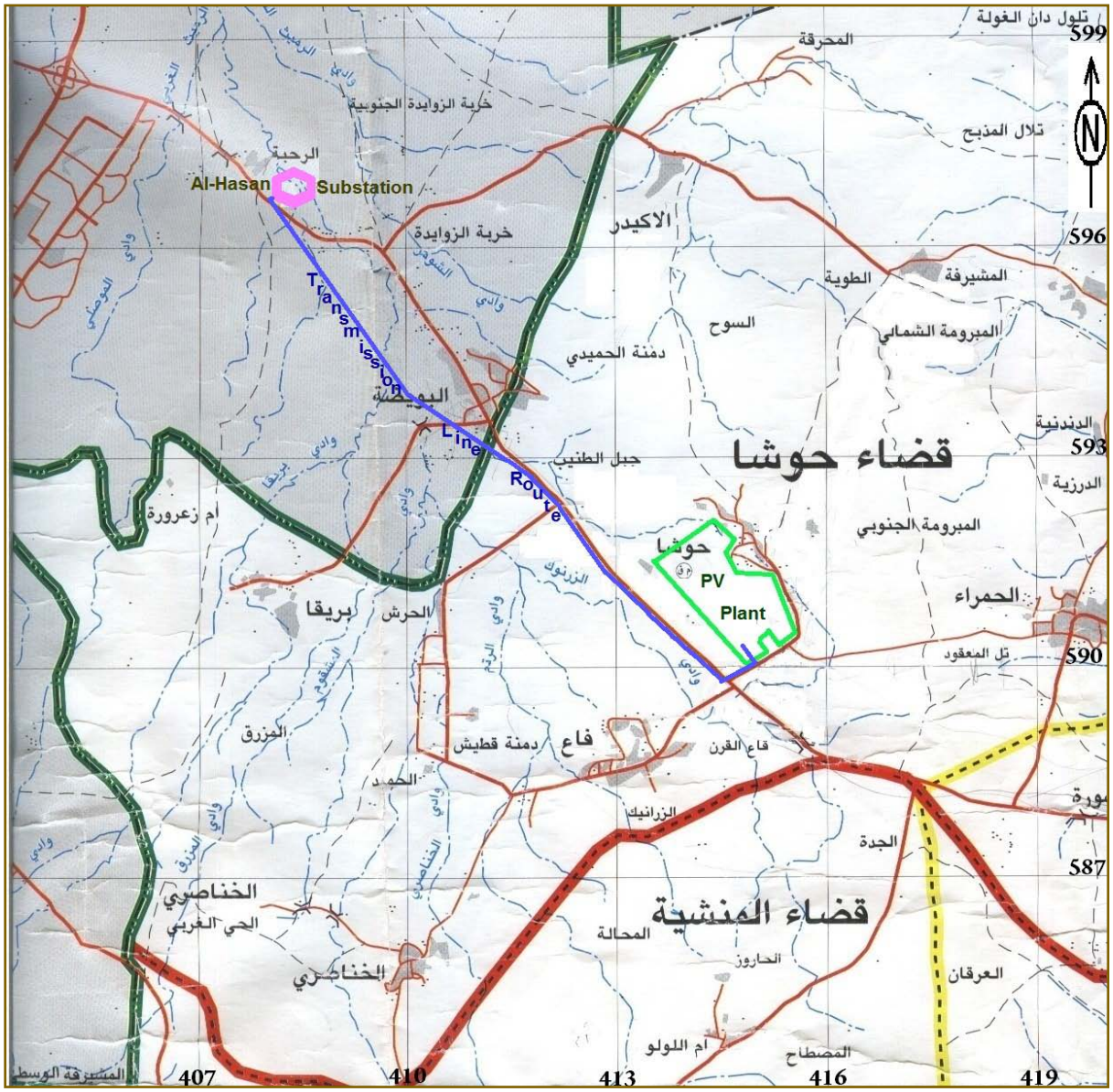


Figure 3.1.1.a: The administrative map of Mafraq Governorate with the location of the PV plant and the transmission line route

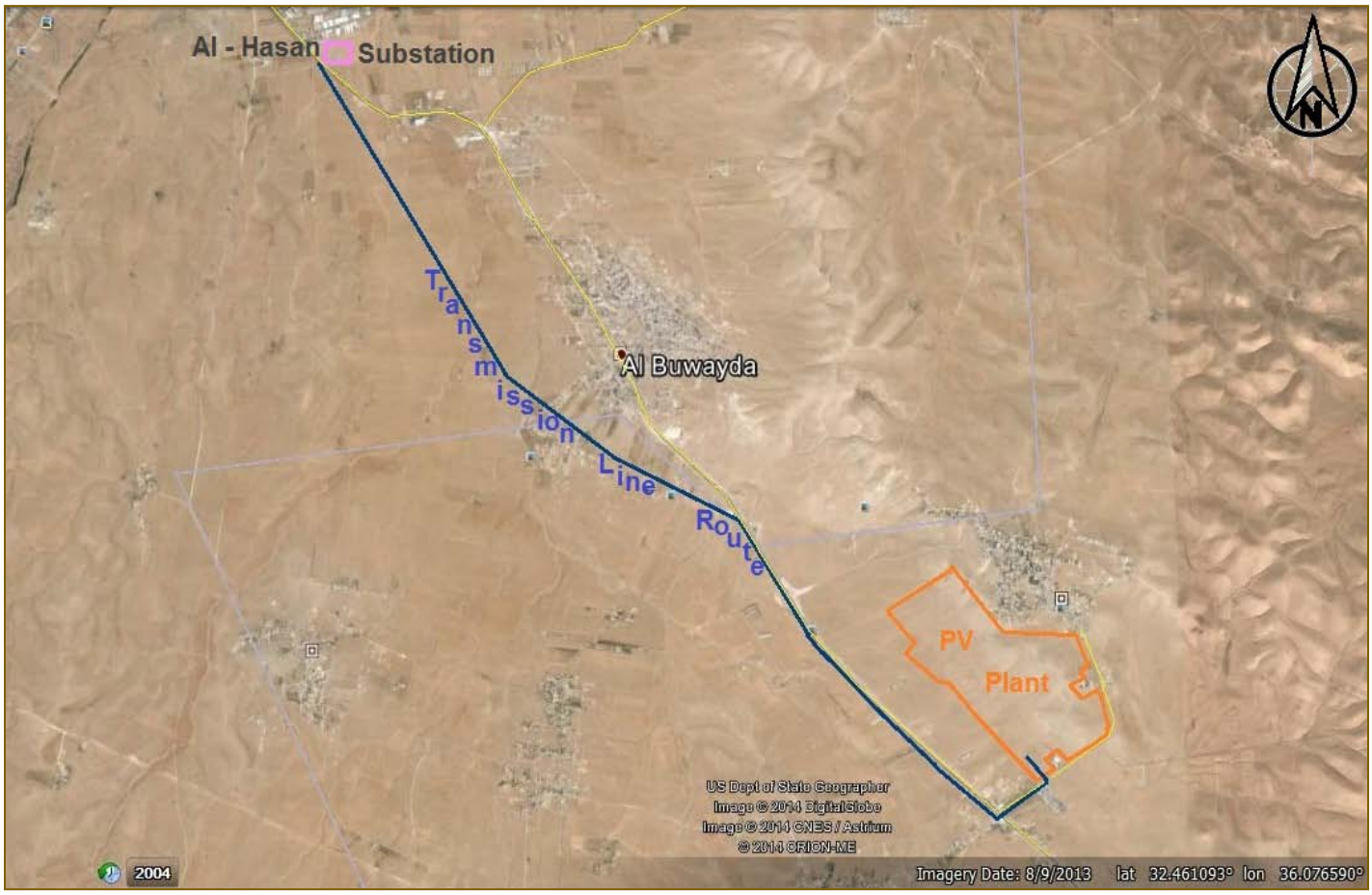


Figure 3.1.1.b: Google map of the PV plant site and the Transmission line route

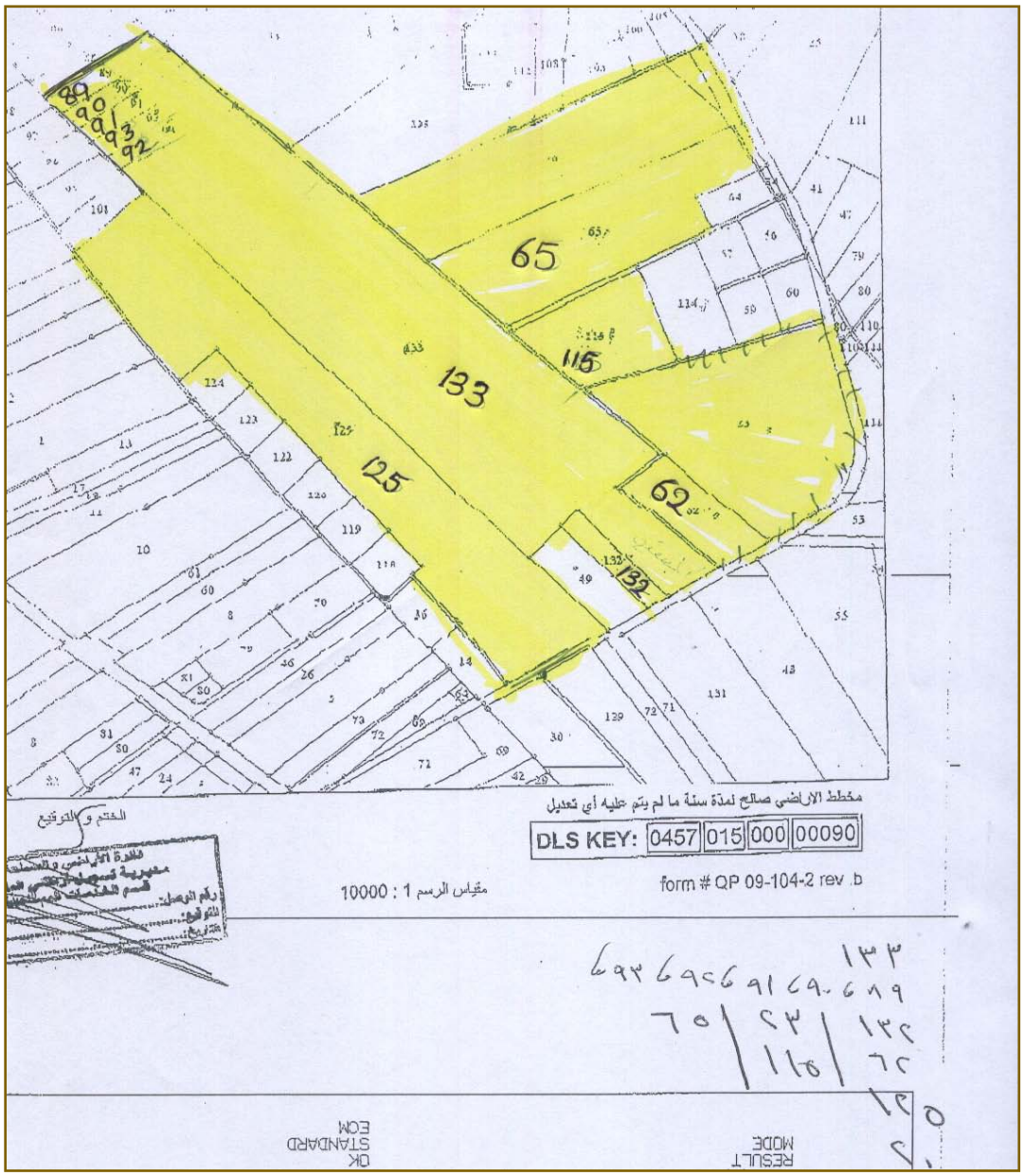


Figure 3.1.2: The layout of the land plots where the proposed project will be established

3.2 Project Components

As mentioned before, the proposed project has two main components; the PV plant and the transmission line. Following is a description for the details of these components.

3.2.1 PV plant Component

It's important to discuss the PV plant technology in this section, in addition to the details of the PV plant.

3.2.1.1 PV Technology

Photovoltaic offers consumers the ability to generate electricity in a clean, quiet and reliable way. Photovoltaic systems are comprised of photovoltaic cells, devices that convert light energy directly into electricity. Because the source of light is usually the sun, they are often called solar cells. The word photovoltaic comes from "photo" meaning light, and "voltaic" which refers to producing electricity. Therefore, the photovoltaic process is "producing electricity directly from sunlight." Photovoltaics are often referred to as PV.

A grid-connected PV system will require a utility interactive DC to AC inverter. This device will convert the direct current (DC) electricity produced by the PV array into alternating current (AC) electricity typically required for loads such as radios, televisions and refrigerators.

Utility interactive inverters also have built-in safety features required by photovoltaic is the field of technology and research related to the devices which directly convert sunlight into electricity. The solar cell is the elementary building block of the photovoltaic technology. Solar cells are made of semiconductor materials, such as silicon. One of the properties of semiconductors that makes them most useful is that their conductivity may easily be modified by introducing impurities into their crystal lattice.

For instance, in the fabrication of a photovoltaic solar cell, silicon, which has four valence electrons, is treated to increase its conductivity. On one side of the cell, the impurities, which are phosphorus atoms with five valence electrons (n-donor), donate weakly bound valence electrons to the silicon material, creating excess negative charge carriers. On the other side, atoms of boron with three valence electrons (p-donor) create a greater affinity than silicon to attract electrons. Because the p-type silicon is in intimate contact with the n-type silicon a p-n junction is established and a diffusion of electrons occurs from the region of high electron concentration (the n-type side) into the region of low electron concentration (p-type side). When the electrons diffuse across the p-n junction, they recombine with holes on the p-type side. However, the diffusion of carriers does not occur indefinitely, because the imbalance of charge immediately on either sides of the junction

originates an electric field. This electric field forms a diode that promotes current to flow in only one direction.

Ohmic metal-semiconductor contacts are made to both the n-type and p-type sides of the solar cell, and the electrodes are ready to be connected to an external load.
When photons of light fall on the cell, they transfer their energy to the charge carriers. The electric field across the junction separates photo-generated positive charge carriers (holes) from their negative counterpart (electrons). In this way an electrical current is extracted once the circuit is closed on an external load.

There are several types of solar cells. However, more than 90 % of the solar cells currently made worldwide consist of wafer-based silicon cells. They are either cut from a single crystal rod or from a block composed of many crystals and are correspondingly called mono-crystalline or multi-crystalline silicon solar cells. Wafer-based silicon solar cells are approximately 200 µm thick. Another important family of solar cells is based on thin-films, which are approximately 1-2 µm thick and therefore require significantly less active, semiconducting material.

Thin-film solar cells can be manufactured at lower cost in large production quantities; hence their market share will likely increase in the future. However, they indicate lower efficiencies than wafer-based silicon solar cells, which mean that more exposure surface and material for the installation is required for a similar performance.

A number of solar cells electrically connected to each other and mounted in a single support structure or frame is called a 'photovoltaic module'. Modules are designed to supply electricity at a certain voltage, such as a common 12 volt system. The current produced is directly dependent on the intensity of light reaching the module.

Several modules can be wired together to form an array. Photovoltaic modules and arrays produce direct-current electricity. They can be connected in both series and parallel electrical arrangements to produce any required voltage and current combination. There are two main types of photovoltaic system. Grid connected systems (on-grid systems) are connected to the grid and inject the electricity into the grid. For this reason, the direct current produced by the solar modules is converted into a grid-compatible alternating current. However, solar power plants can also be operated without the grid and are then called autonomous systems (off-grid systems). More than 90 % of photovoltaic systems worldwide are currently implemented as grid-connected systems. The power conditioning unit also monitors the functioning of the system and the grid and switches off the system in case of faults.

JSO proposed solar projects is a grid connected system that connects the generated electricity to the grid through a transmission line of about 13 km length that will transmit the electricity from the proposed solar plant to Al-Hassan Substation which is located north west of the proposed solar project plant. Figure (3.2.1) shows a typical solar cell.

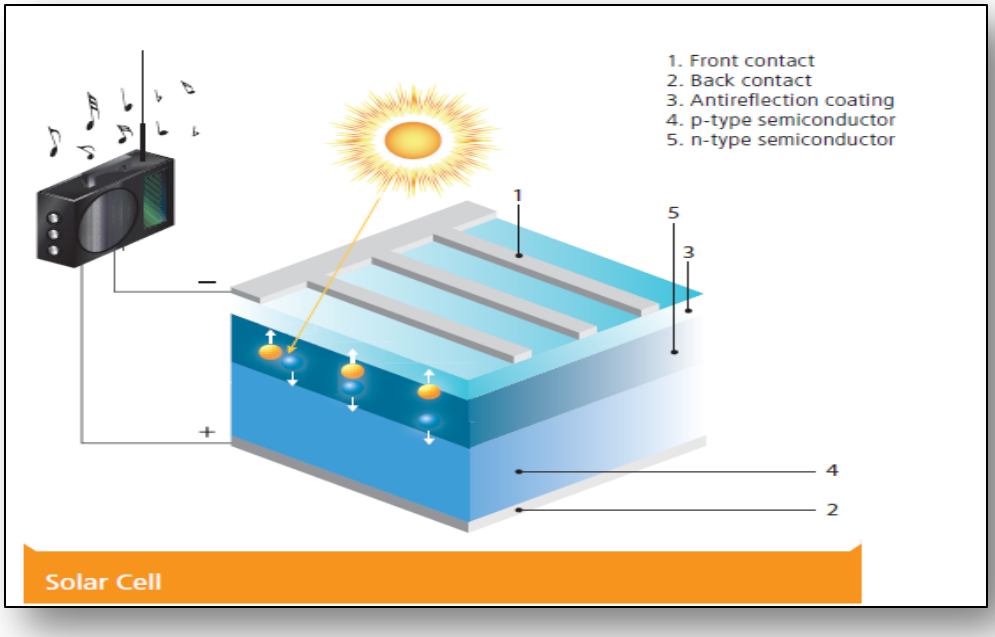


Figure 3.2.1: A typical solar cell

3.2.1.2 Photovoltaic Plant Constituents

The project is to utilize solar energy to generate electric power with a capacity of 20MWac to be connected to the national grid in Jordan. The proposed photovoltaic plant consists of the following main components:

- Solar field: Main components of photovoltaic power plant or "solar field" consists of a large group of semiconductor technology based silicon solar cells arranged in what is known as solar PV panel or solar module. Solar panels convert impinging sun rays (photons) to electrons. The electrons' flow generates direct current (DC) electricity which gets collected and channeled into an electronic device "inverter" to invert the DC current into Alternating Current (AC); the form of electricity used to power homes, neighborhoods, factories, cities, etc.

- Racking: Structural components which support the PV panels. These structures could be stationary (fixed) or movable thru utilizing a "tracking system" to track sun movement during the day, thru out the entire year.
- Tracking: This is a mechanical system attached to the racking system to enable it to track sun movement. This could be a one axis tracking system (similar to the system used in this project) and it could also be a two axis tracking system, as another alternative.
- Other electric and/or electromechanical system components, such as cables, inverters, transformers, switchgear and controls are used to control and condition the power output of the solar field. An inverter is used to convert the electricity which is produced as direct current in to alternating current for the purpose of grid connection. in order to connect a large solar facility to the national grid , numerous inverters will be arranged in several arrays to collect , and convert the produced power
- Connection to the grid: Routing energy generated from solar field to the national electricity grid.

3.2.1.3 Module Components Assembly

A typical solar module consists of several individual cells wired together and enclosed in protective material called encapsulant, commonly made of ethylene vinyl acetate. To provide structural integrity, the encapsulated cells are mounted on a substrate frequently made of polyvinyl fluoride. Both ethylene vinyl acetate and polyvinyl fluoride are widely considered to be environmentally preferable to other chlorinated plastic resins. A transparent cover, commonly glass, further protects these components from weather when in place for electrical generation. The entire module is held together in an aluminum frame. Most modules also feature an on board electrical junction box.

3.2.1.4 PV plant Infrastructure

The infrastructure of the PV plant component of the project comprises the followings:

- Energy source to provide the PV plant with the needed electrical power particularly during the construction phase, and lighting the proposed site;
- Water supply source; the proposed project will have a permanent water source from the public water supply from WAJ; the main use of the water in this project is for the construction and the cleaning of the solar panels in the operation phase, in addition to the use of water for the domestic purpose;
- Septic pool for containing the sewage water that is generated by the project operatories. This pool will be of about 50 cubic meter capacity, and will be evacuated by sewage tanks to approved waste treatment plant in the area such as Mafraq waste treatment plant;

- Water distribution network to the facilities of the project;
- Sewage water network ;
- Access Roads and Site Access about 2500 m within the site;
- Communication network; and
- Warehouse of about 200 m^2.

Additional infrastructure that would be required for the project includes the following:

- Site fencing with about 4735 m.
- Within the site storage area there would be bounding for transformers or any other oil containing equipment to ensure full containment in the event of any oil leakage.

3.2.2 The transmission Line Component

3.2.2.1 Transmission line Technology

The electric power transmission system is often referred to as a grid. Redundant paths and lines are provided so that power can be routed from any generation facility to any customer area through a variety of routes, based on the economics of the transmission path and the cost of power. The redundant paths and lines also allow power flow to be rerouted during planned maintenance and outages due to weather or accidents.

Power transmission occurs via a system of underground or/and above ground power lines and towers located between a power plant and a substation. Transmission systems are utilized to suspend high or medium voltage overhead power lines.

An overhead power line is an electric power transmission line suspended by towers or poles since most of the insulation is provided by air, overhead power lines are generally the lower cost method of transmission line for the large quantity of electric power.

For the transmission line component of the proposed project, Al Shamil Engineering consulted NEPCO technical staff about the proposed transmission line capacity to transmit the generated power from the proposed Husha PV plant to the Al Hasan sub-station in Ramtha district of Irbid governorate. According to NEPCO, the proposed transmission line should be 33 Kv in compliance with the Al Hasan sub-station characteristics, which is 132/33kV sub-station.

However, the selected alternative for the transmission line of this project will be overhead line. Figure 3.2.2 shows a typical transmission line of 33 Kv.

Figure 3.2.2: A transmission Line of 33 Kv

3.2.2.2 Transmission Line Constituents

As mentioned earlier, the proposed project will involve development of a 13 km, 33 kv transmission line between Husha PV plant and the Al Hasan sub-station in Ramtha district. To ensure the efficient functionality of the proposed transmission overhead line, all of the transmission line constituents will be installed using the best engineering practices. Following is a brief discussion for the transmission line constituents.

Support Structures

Structures for overhead lines take a variety of shapes depending on the type of line. Structures may be as simple as wood poles directly set in the earth, carrying one or more cross-arm beams to support conductors, or "armless" construction with conductors supported on insulators attached to the side of the pole. It's supposed that concrete poles will be used for the proposed transmission line, and will be designed for the loads imposed on it by the conductors.

For the proposed project, the overhead transmission line consists of about 240 poles along the line route that support the conductor that carry the electricity, a high voltage conductor diameter is used to maximize the carrying capacity. The poles are supposed to be spaced 50 meter interval. Insulators are used to isolate the poles from the conductors that carry the electricity as shown in figure (3.3.1).

Figure 3.3.1: the spacing between the poles

Conductors

There are three conductors in the proposed transmission line, which are supported horizontally parallel to each other.

Insulator

Suspension and tension insulator sets of the cap and pin, pin or post type insulator, shackle insulators and stay insulator shall comply in galvanized respects with the requirements of the technical specification for insulator referenced.

All insulators and insulator fitting shall be handled carefully during transportation, assembly and installation on the support structure to avoid chipping or damage and shall be cleaned when installed.

Foundations

The foundation design criteria shall be determined from the classification of the ground into which the structure is to be erected. In general the planting depth of the pole shall not be less than one sixth of the total length of the pole above the ground level, and shall not be less than 1.5 meter.

3.3 Project Implementation Phases and Requirements

The EIA study for the proposed project should cover the project phases' activities as they create the project impacts on the environmental components, the following project phases will be covered in this EIA study.

3.3.1 Pre-construction and Construction phase

3.3.1.1 PV Plant Component

The main activities during this phase will be excavation and earthworks for the internal access roads, building of the plant structures and facilities, and installation of photovoltaic panels and modules. The excavation will be conducted to prepare the land of the site for erecting of the structures needed for installing the photovoltaic system.

The equipment to be used in the site preparation and construction phase will require various forms of energy which will include manpower, charged of fossil fuel. Fuel based equipment to be used will include Dozer, loader, mixer, vibrators, compressors, etc… .

This phase also comprises the construction and the paving of the internal roads that have lengths of about 2.5 km to connect the photovoltaic plant facilities together and with the accessible road.

The duration of this phase is expected to be 18 months, during which, it requires the temporarily construction equipments and labors, the equipments include; crane, dozer , jack hummer, loaders, compressors, services vehicles, in addition to the construction material (aggregates, sand, cement, steel, and water and other needed facilities). During this phase, offices and other infrastructure will be constructed. In addition to these equipments, **120 persons** are needed to run all activities of this phase. Those are divided into low skilled workers (construction labor, security staff), semi skilled workers (drivers, equipment operators), and skilled personnel (engineers, land surveyors, project managers). The majority of low skilled employment opportunities associated with the project is likely to benefit members from local communities.

3.3.1.2 Transmission line

The main activities during the construction phase will be excavation of materials for the poles foundation and installation of poles, conductors, and their support components. Following are the main activities of the construction phase.

Seclusion of project way leave and clearing

The way leave will be carried out before the implementation of the project commencement.

Excavation for foundation works

The project area is made of different types of soils and geological conditions, the excavations will be conducted to create holes for erecting the concrete poles and trenching for cable installation, the trenching will include concert duct bank and will be buried directly. The excavation and construction of the foundation shall involve the use of hand tools like crowbars, mixer, vibrators, and trappers but in case of rocky areas compressors and drills will be used.

The equipment to be used in project construction will require various forms of energy which will include manpower, charged of fossil fuel. The manual equipment to be used in the development project includes crowbars, spanners and ropes. Fuel based equipment to be used will include mixer, vibrators, compressors and drills.
These activities shall utilize labor from neighborhood to supplement some machinery works such as that by the concrete mixers, thus creating employment for the local population.

As the line route passes near paved roads, the contractor should work in full coordination with the ministry of public works and housing.

Stinging and Tensioning

The conductors will be installed using a trolley to unwind them from the cable holders, and using lift crane to elevate the conductors on the pole.

Landscaping

After successful completed the transmission line construction work, the project contractor should rehabilitate the project ROW that could be subjected to clearing by planting indigenous plant species.

The expected pollutants and wastes that may result from the above mentioned activities of the two components during this phase are the followings:

- Dust caused by earthworks using heavy equipment and trolley;
- Gases Emissions (fossil fuel charged equipment and Vehicles);
- Noise generated from the heavy equipment and machinery;
- Solid and Liquid wastes;
- Increased traffic Load;
- Accidents.

3.3.2 Operation and Maintenance Phase

This phase is considered the main project's phase during which the electricity will be generated and dispatched to the Al Hasan Electric substation. The activities of this phase are considered the most important ones in the project as they are continuous activities over the lifetime of the proposed project and will have impacts on in-site and neighboring.

3.3.2.1 PV Plant

The photovoltaic plant needs a control room to control all process in the plant. The activities of this phase create noise, solid and liquid wastes, oil spillages, work accidents. These activities may impact the occupational health and the biodiversity in the PV plant site.

The needed staff for the operation of the photovoltaic plant includes engineers, technicians, and working labors. The duration of this phase is expected to be 20 years, in which permanent jobs will be created. The total staff for this phase is estimated to be **about 19 person including** low skilled, semi-skilled and skilled employees.

The majority of work opportunities associated with the operational phase is likely to be taken up by members from the surrounding villages.

3.3.2.2 Transmission line

General Maintenance

Activities undertaken during the transmission line operation phase are minimal and will include clearing of overgrown vegetation and repairs of any defect that can be detected along the transmission line.

Waste Management

The project proponent will be required to manage the waste generated during the operation phase of the transmission line appropriately. This can be done by providing facilities for temporary storage or handling of the solid and liquid waste generated during the maintenance period.

The expected pollutants and wastes that may result from the above mentioned activities during the operation phase for the two components of the project (PV plant, transmission line) are the following:

- Electromagnetic Fields (EMFs);
- Noise resulting from the project operation and maintenance;
- The physical presence of the project structures;
- Radio interference; and
- Accident events.

3.3.3 Decommissioning phase

This phase includes the following activities in the two project's components:

Demolition and material removal Works

Upon decommissioning, the components of the PV plant and the transmission line will be uninstalled. This will produce a lot of solid waste, which can be reused for other projects and construction works or if not reusable, disposed of appropriately by a proponent waste disposal company.

Site Rehabilitation

Once all the waste resulting from demolition and dismantling works is removed from the site, the site will be rehabilitated through replenishment of the topsoil.

The expected pollutants and wastes that may result from the above mentioned activities during the construction phase are the following:

- Dust caused by earthworks using heavy equipment and trolley;
- Gases Emissions (fossil fuel charged equipment and Vehicles);
- Noise generated from the heavy equipment and machinery;
- Solid and Liquid wastes;
- Increased traffic Load; and
- Accidents

The impacts of this phase are temporary and are related to the period of accomplishing this project.

The requirements of this phase are Jack Hummer, Loader and large trucks for material transporter; this phase needs **60 people** for a very short period.

3.3.4 Project requirements

The program of work is a special document that describes the construction process in detail, the work schedule, the amount of man power and machinery used. It will be developed by the contractor selected following an invitation to tender (ITT). Nevertheless, the standard practice in constructing PV plant and the transmission line is discussed in the following paragraphs.

3.3.4.1 PV Plant Components

Pre-construction and Construction phase requirements

This phase requires the temporarily construction equipments and labors, the equipments include; crane, dozer, jack hummer, loader compressors, services vehicles, in addition to the construction material (aggregates, sand, cement, steel, and water). In addition to this equipment, 120 persons are needed to run all activities of this phase including construction skilled and non skilled labors, security staff, drivers, and equipment operators, etc.., .

Operation phase requirements

The needed staff for the operation of the photovoltaic plant includes engineers, technicians, and working labors for each working shift. The total staff for this phase is estimated to be about 19 persons according to the project proponent (JSO and their EPC).

Decommissioning phase requirements

The requirements of this phase are Jack Hummer, Loader and large trucks for material transporter; this phase needs 60 people for a very short period, including construction skilled and non skilled labors, drivers, and equipment operators, etc.. ,

3.3.4.2 Transmission Line

Construction phase requirements

The construction process is put into practice by groups of single purpose workers that execute their particular front of work. The construction teams will be about 50 people divided to crews, working one after another, with each crew responsible for one of the construction assignment (Preparing the RoW, laying the foundations for the poles and trenching for cables, assembling the poles on the ground, erecting of the poles and installing of trenching cables and wires and testing and commissioning the line).

Workers involved in the construction will have working camp dwell within the PV plant for the workers in the two project components.

There will be transport (Pick-Up) link arranged between the construction sites and the places of residence of the construction bridges.

Operation phase requirements

During the operation phase of the project, way leaves will be maintained through manual vegetation clearing. Once the poles and the other components are erected and structural integrity established, minimal maintenance is required and a routine aerial inspection and ground inspection will however be done annually.

Decommissioning phase requirements

The requirements of this phase are Jack Hummer, Loader and large trucks for material transporter; this phase needs 50 people for a very short period, including construction skilled and non skilled labors, drivers, and equipment operators, etc.. ,

The equipment machinery and manpower required for the construction phase in the two components of the project are shown in tables 3.3.1 and 3.3.2.

Table 3.3.1: Equipment needed in the construction phase for the two components of the project

Equipment	No	Function
Dozer	4	Will be used for land digging, and removing of the dislocated material
Jack hummer	5	Will be used for material dislocation from the bed rock, removal, and breaking to smaller size
Loaders	5	Will be used for material removal, cleaning, collection, and loading on the large transport trucks
Compressors	5	Will be used for excavation in the bedrock
Trucks	8	Will be used for loading, transport, and unloading earth works material at allocated disposal sites
Pick Up (Double Cabin)	5	Will be used as a supportive vehicle needed for the work on site
Lifting Crane	5	Will be used to install the conductors to unwind them from the cable holders

Table 3.3.2: The man power needed during the construction phase of the two components[1]

Position	Number
PV Plant	
Engineer	4
Skill labor	10
Forman	8
Loader Operator	10
Dozer Operator	8
Jack hummer driver	10
Mechanics	6
Pick Up Driver	8
Site Labor	56
Transmission Line	
Engineer	2
Skill labor	5
Forman	4
Compressor Operator	5
Packhole Operator	4
Crane Operator	4
Mechanics	2
Pick Up Driver	4
Site Labor	20
Total	**170**

[1] The number of workers from the local community should be according to the guidelines of the applicable Jordanian Labor law

The equipment machinery and manpower required for the operation and maintenance phase for the two project components are shown in tables 3.3.3 and 3.3.4.

Table 3.3.3: Equipment needed in the operation and maintenance phase

Equipment	No	Function
Lifting Crane	3	Will be used to lift up workers to the isolators' level
Mobile Water Tanks	2	Will be used for washing isolators and PV cells
Pick Up (Double Cabin)	3	Will be used for inspection visits and transporting the working crew

Table 3.3.4: The man power[2] needed during the operation and maintenance phase for the project components

Position	Number
PV Plant	
Security	6
Cleaning staff	6
Technicians	4
Managers	3
Transmission Line	
Engineer	1
Technicians	2
Up Lifting Operator	1
Site Labor	2
Pick Up Driver	2
Water tank driver	2
Total	**29**

[2] The number of workers from the local community should be according to the guidelines of the applicable Jordanian Labor law

3.4 Project Alternatives

The definition of alternatives in relation to a proposed development means different means of meeting the general purpose and requirements of activity which may include:

- The property on which or location where it is proposed to undertake the activity;
- The type of activity to be undertaken;
- The design or layout of the development;
- The technology to be used in the development; and
- The operation aspects of the development.

Essentially there are two manners of alternatives:

- Incrementally different (modifications) alternatives to the project
- Fundamentally (totally different to the project)

However, following is a discussion for the two project components alternatives.

3.4.1 PV Plant alternative

Due to the nature of the proposed PV plant project, the location of the project is largely dependent on technical factors such as solar irradiation, climatic conditions, extent and topography of the site, land availability and available grid connection. The proposed site was identified by JSO as being technically feasible. No feasible site alternatives within the project area were identified for this specific project by JSO.

The following characteristics were considered in the selection of the proposed PV plant site. Based on these considerations, JSO considers the proposed site as their highly preferred site for the development of the PV plant in Husha.

Site extent: Space is a restraining factor in the case of the technology proposed for the project; a PV installation requires an area of up to 20 dumus per MW. Therefore an area of approximately 400 dunum of 20 MW would be required for a PV plant. The proposed site, which is approximately 1400 dunum in extent, will therefore be sufficient for the installation of the proposed plant and will allow space for the avoidance of any identified environmental constraints within the final design of the plant and any future extension.

Site access: The site can be accessed easily via existing access roads from Mafraq to Irbid and from Husha road that passes next to the western side of the project.

Climatic conditions: The economic viability of a photovoltaic plant is directly dependent on the annual direct solar irradiation levels. A study of available irradiation data shows that the proposed site is continuously irradiated by the sun, which is suitable for PV technology.

Site slope and aspect: the project site is located on flat terrain with a level surface area, and has a minimal gradient which is suitable for the PV panels. This reduces the need for extensive earthworks associated with the leveling of a site, thereby minimizing environmental impacts. The proposed area for the PV plant is located on flat terrain with undulating hills.

Generally the alternatives of such PV plant are:

Electrical evacuation

According to NEPCO instruction to JSO, the generated electricity from the proposed plant will be evacuated to the national grid via a transmission line of 33 Kv and about 13 Km length; this line will transport the generated electricity to the Al Hassan electric substation (132/33 Kv) for a distance from the PV plant site of about 13 Km.

Location alternative

In determining the most appropriate site for the establishment of a PV plant within Husha area; various options were investigated by JSO. The prefeasibility sit selection process has considered particular criteria suitable to the deployment of the proposed PV plant, the criteria which result in the selection of the proposed site includes the topography, land availability, land value and size, solar irradiation, extent of the proposed site, site accessibility and connection to the national grid.

The 'Do Nothing' Alternative

The 'do-nothing' or 'no-go' alternative is the option of not establishing a PV plant in Husha proposed site. The electricity demand in Jordan / north of the country surpassed existing power generation capacity, causing black-outs and load shedding. Jordan requires additional capacity if it is to meet the growing demand for electricity. The 'do nothing' option will, therefore, contribute to these electricity demands not being met. Not meeting the growing electricity demand will have major adverse impacts on economic activity and economic growth in Jordan, which in turn will have an adverse impact on socioeconomic development in Jordan. Additional electricity generation options will contribute to meeting this energy demand. The recent increase in oil prices, the exhaustibility of fossil fuels and the urgent need for stable, reliable, non-polluting sources of electrical energy that are indispensable to a modern industrial economy focuses attention on alternative energy, such as renewable energy sources.

The establishing of the proposed PV plant will also aid Jordan in meeting its commitments to reduce green house gas emissions, made in terms of the United Nations Framework Convention on Climate Change (1997) and the Kyoto Protocol (2002). The "do-nothing" alternative will not assist the country in meeting these renewable energy targets or aid in reducing Jordan dependence on imported fuel for electricity generation.

The proposed PV plant will create opportunities for about 120 jobs for the construction phase and about 19 jobs for the operation phase of the project. With the "do nothing alternative", Husha community will lose these opportunities, in addition to teaching people from community on PV technology.

3.4.2 Transmission Line Alternative

For the proposed project, there are two alternatives for the transmission line route to dispatch the generated electricity from the proposed PV Plant to the Al Hassan electric substation. These alternatives are entirely located within the deteriorated part of the Mafraq IBA, although one of them will be closer to the southern edge of the above mentioned IBA.

Alternative One

- This alternative goes along the right of way of Mafraq- Irbid road, crossing Buwaida village before reaching the Al Hassan electric substation.
- The length of this alternative route is about 13 km.
- This alternative may have two parts:
  - ✓ Overhead part
  - ✓ Underground part

Alternative Two

The second component of the project is the transmission line, for which two alternatives were discussed, the selected alternative of the transmission line route will be of overhead type, and will cross over public lands for a distance of about 13 km. this alternative starts from the PV Plant and passes through the ROW of Husha road until its intersection with Mafraq – Irbid national road no.10, then it goes west in the ROW of the national road no.10 for a distance of 5km The TL then turns south west of the road no.10 through the ROW of planned and approved streets until it reaches the Al Hasan electric substation for the distance of about 8km.

Alternative two is selected to avoid the followings:

- Crossing Buwaida village where the transmission line must be underground;
- The significant technical challenges that need to be overcome; these are providing sufficient insulation so that cables can be within inches of grounded material, and dissipating the heat produced during the operation of the electrical cables; and
- To reduce the cost of the line construction.

4. Approach And Methodology to Undertaking the Proposed Project EIA Study

4.1 Generality

An EIA process is dictated by the EIA Regulations which involves the identification of and assessment of direct, indirect, and cumulative environmental impacts (both positive and negative) associated with a proposed project. The EIA process forms part of the feasibility studies for a project and comprise a scoping Phase and EIA phase which culminates in the submission of an EIA Report together with an Environmental Management Plan (EMP) to the competent authority for decision-making.

The project team prepared a Terms of Reference (TOR) for the development of the Environmental Impact Assessment (EIA) for the proposed project in order to identify the major potential environmental impacts of this project. The preparation of the EIA study is in response to the guidelines of the ministry of Environment and IFC applicable requirements. To accomplish the scope of work and achieve the objectives of the study, Al Shamil Engineering separates the major tasks into two phases: **Phase 1, which is concerned with the work leading to the preparation of terms of reference for EIA** and **Phase 2, which is concerned with the completion of EIA.**

4.2 Project Initiation

Upon attaining authorization to proceed, Al Shamil Engineering study team met the JSO involved team to:

- Introduce key team members,
- Discuss specific details of the study and approach, and
- Obtain all relevant engineering designs and descriptive information along with the possible operations of the proposed project.

However, the consultancy team communicated with JSO people as deemed necessary during the course of the study.

4.3 Site Reconnaissance

The project team undertook site reconnaissance through several visits to orient itself to the proposed project site, roads, and community in the adjacent area. The team identified the area surrounding the project site, roads and traffic, agricultural activities, land use, water resources, soil cover, vegetation cover, other distinguished features, and environmental characteristics of the area. In addition to recognize the proposed project site characteristics, such as topography, existing activities, land use, and other main features. Annex (1) shows some of the photos taken during the site visits.

4.4 Screening

Screening is the procedure used to determine whether a proposed project is likely to have significant impacts on the environment. This step was conducted in the early stages of the project EIA process according to the environmental impact Assessment Regulation No.37 of 2005 of Jordan/ Regulation No. (37) of 2005 through the following:

1. Project Description

- The nature of project and project implementation phases, the construction, operation, rehabilitation stages.

The targeted project is composed of two components; photovoltaic cells and a transmission line.

- The nature of production processes (the quality and quantity of the used substances and the productions' inputs and outputs.
  - The project uses the PV semi-conductor cells of polycrystalline silicon;
  - The projects spans over 1400 dunum;
  - The input substance used is solar energy and the semi conductor cells;
  - The output is 20 MW electricity;
  - The transmission line route is about 13 km length;
  - The transmission line is of 33kv capacity;
  - The transmission line is entirely overhead line;

- Estimating the expected quality and quantity of wastes and emissions resulted from operating the project (water, air, soil, noise, vibrations, light, emissions and heat).

  For the targeted project, these are presented in the following table.

Waste	Quality	Quantity
Water	Domestic wastewater	~ $2m^3$/day
Air emissions	No air emissions are expected during the operation phase	
soil	No soil degradation	
Noise	Very low noise during operation	

- Estimating the number of people, vehicles and equipments through different project stages.

  Expected number of people working during the construction phase is 120 persons, and during the operation phase is 19.

2.List of the main proposed projects' alternatives including the design, location and the used techniques in addition to discuss the main reasons to choose and prefer the proposed project than other projects, taking into consideration the environmental impacts.

- The selection of the PV plant site and the Transmission line route, the design and the technology used is based on the following:
  - Available land
  - Lowest cost (land, technology)
  - Least damage to the environment
  - Climatic conditions
  - The distance between the electric substation and the PV plant site.

Accordingly, the most appropriate alternative is selected for the PV plant and the transmission line and is approved by the ministry of environment.

3.The most important environmental aspects affected by the proposed project as the public health, infrastructure, flora, fauna, soil, water, air, weather parameters, natural aspects and the archaeological sites and the interrelationships between these aspects were considered.

Based on the above screening process, with reference to annex (2) of the environmental impact Assessment Regulation No.37 of 2005, and the discussion with the directorate of licensing and guidance in the ministry of environment, it was concluded that this project needs **EIA** according to the requirements of "Electricity generating plants".

4.5 Terms of Reference of the EIA

A draft TOR outlining the main issues to be considered and approaches to be taken was prepared and submitted to the Ministry of environment. This TOR includes all EIA requirements and a variety of approaches to public consultation by the consultant and the Ministry of Environment that are considered to ensure that all key stakeholders are involved in the process.

4.6 Background Data Review and Gaps Identification

It is assumed that certain reliable baseline data currently exist on the natural environment for the proposed PV plant area, including air environment, i.e climatology and meteorology, terrestrial environment, i.e geology, geomorphology, soils, ecology and biotic resources, hydrology, hydrogeology, and water use, land use, archeological resources, and Additional specific information were obtained by site visits.

To update and provide complete coverage of the available database, the study team undertook a literature and information search based on personal contacts with appropriate government agencies and other sources. The team maintains and book keeps of accurate correspondence information as a file with names, titles, addresses and telephone numbers of all individuals and agencies contacted the data and method of contact as well as the subject matter discussed.

Based on review of all available information, a description of environmental setting was prepared, including site area description, the atmosphere environment (climate attributes, air quality, noise), the terrestrial environment (geology, physiography, soils, vegetation, biodiversity species of special concern), water resources, land use), heritage resources and socio–economic and demography characteristics (population, local interest group, social and community services/ infrastructure, industrial base, retail and commercial services section, labor force, accommodation as well as energy transmission and visual resources).

4.7 Public Involvement and Consultation

The aim of the public participation process is primarily to ensure that:

- Information containing all relevant facts in respect of the proposed project is made available to potential stakeholders and I&APs;
- Participation by potential I&APs should be facilitated in such a manner that all potential stakeholders and I&APs should be provided with a reasonable opportunity to comment on the proposed project;
- Comments received from stakeholders and I&APs should be recorded and incorporated into the EIA process;

For the purpose of this study, the consultation is to be undertaken through public scoping session and community consultation.

4.7.1 Public Scoping session

According to the national regulations, a scoping session shall be organized by the ministry of environment and the participation of other regulating authorities, which have jurisdiction to the proposed project. According to the procedure of the MoENV, this scoping session was conducted in 28.8.2014 in Amman.

4.7.2 Community consultation

In order to accommodate the varying needs of the local community (Husha, Buwaida) interested and affected people, a consultation through interviews and focus group meetings with selected people who represent different sectors of the community was conducted, in which gender issue was considered.

4.8 Preliminary evaluation of issue

Based on the review of the available data and the discussion outcomes during the public scoping session, a preliminary outlines of the issues to be addressed in developing EIA will be prepared. The issues to be addressed will include the list of concerns shown in the following table. These issues have occupational, public health, biodiversity, water resources, traffic, archeological and socio–economic implications. Table (4.8.1) shows the primary issues of concerns.

Table 4.8.1: The primary issues of concerns

Environmental issue and potential pollutant	Project Phase		
	Construction	Operation	Decommissioning
Water Resources which may impacted by			
▪ Liquid wastes	X	X	X
▪ Solid wastes	X	X	X
▪ Fuel Spills	X	X	X
▪ Oil spills	X	X	X
Occupational and Public health which may be impacted by			
▪ Dust	X	X	X
▪ Noise	X	X	X
▪ Accidents	X	X	X
▪ Nuisance	X	X	X
▪ Liquid and solid wastes	X	X	X
	X	X	X
Biodiversity which may impacted by			
▪ Earth works	X		
▪ Solid and liquid wastes	X	X	
▪ Accidents	X	X	
▪ Photovoltaic and transmission line operation	X	X	X
Comprehensive social impacts	X	X	X
Archeology which may impacted by			
▪ Earth works	X		
Traffic caused by proposed project activities may have the following impacts			
▪ Noise	X	X	X
▪ Dust	X	X	X
▪ Gas emissions	X	X	X
▪ Accidents	X	X	X
▪ Traffic load	X	X	X

X: exists

4.9 Final TOR for EIA

Based on the program outlined above for TOR preparation, a final TOR is agreed to with Ministry of Environment. The TOR provides an outline of the EIA development structure and the methodology to be followed. TOR includes a detailed definition of potential environmental components that should be assessed in the EIA development study and the extent of the assessment including level of data required. The final TOR report for this EIA STUDY is approved by the MoEnv[3].

4.10 Elaboration of Environmental Impact Assessment and EIA study report completion

Al Shamil Engineering prepared the EIA for the proposed photovoltaic plant through addressing project specific impacts. To accomplish this phase, the consultant carried out the following tasks.

Environmental Baseline Studies

The baseline environment of the proposed project area is a very important issue in the development of the EIA for this project. It will be used as a reference for any changes caused on the environment elements or components by the activities of the proposed project. Al Shamil Engineering (consultant) will describe briefly the exiting environmental components in the following manner:

- **Physical environment**
- **Biological Environment**
- **Socio-Cultural Environment**

4.11 Determination of the potential impacts of the proposed project

Activities of the site preparation and construction, operation and decommission phases of the proposed project will generate wastes and pollutants that may have impacts on the environment of the area of this project. To identify these impacts, the wastes and pollutants will be identified in the first step.

The expected wastes and pollutants may include solid and liquid waste, machinery and vehicles waste, noise, dust, gas emissions, etc. Based on the identified wastes and pollutants, this task comprises the impacts of proposed project on the environment, specifically the valued components of the environment (VECs) that include

- Occupational and public health,

[3] A copy of the TOR approval is shown in annex (6)

- Socio-economic condition,
- Water resources and use,
- Biodiversity, and
- Archeology.

Based on the proposed project documents, activities of the different phases of the project implementation, baseline data, and the national and international legislations and standards, the potential impacts of the proposed project will be identified and assessed.
The consultant makes detailed analyses of the major impact issues including significant major positive and negative impacts, and immediate and long term impacts as well as unavoidable impacts.

4.12 Environmental Management Plan (EMP) development

Based on the JSO data project design and activities, baseline information, potential impacts both positive and negative of the proposed project are identified and assessed. This project has positive economic impacts of generating electricity from renewable source and supplies it to the national Jordanian grid. Potential negative impacts of the proposed project include occupational and public health, environmental and infrastructure related impacts such as increasing traffic, noise, dust, gas emissions, accident and biodiversity impairment. These impacts can be minimized by the implementation of appropriate mitigation measures, such as standard dust and gas emission control measures, and noise silencing, etc. As required, the EMP for the proposed project will include the following:

- **Development of mitigation Measures:** This includes the mitigation measures that will mitigate or delete some impacts that may affect the environmental components in the project area;
- **Development of an environmental monitoring plan:** This plan includes preparation of a detailed plan and a monitoring program for the ambient air including dust, gas emission, noise and water resources, and a full description of the parameters, frequency for each parameter, minimum detection limits; acceptable numerical monitoring levels. This information should be developed on an annual basis, equipment or services to be contracted and other details required for monitoring implementation;
- **Identification of institutional training and strengthening** to supervise environmental mitigation and monitoring.

5. Baseline Environmental Status

The baseline environment is used to set the reference level to evaluate or predict the different impacts of the project activities. Data collection and field investigations are the main sources to establish the baseline environment. The baseline includes description of:

5.1 Physical Environment

The components of this environment include soil and geology, water resources (surface, groundwater and treated wastewater) of the project area, existing and proposed project water uses. Hydrology and storm water drainage of the project site is defined to determine the maximum average discharge of the flow in the area. This discharge is calculated using state of the art methods like the Natural Resources Conservation Services Curve Number Approach (NRCSCN). Climatic and meteorological data including wind direction and speed are obtained from the metrological department for the nearest representative climatic station; which is Mafraq climatic station.

5.1.1 Climate

Jordan climate varies from the Mediterranean climate to the western mountain chains to desert climate in the eastern plateau, with tropical climate in the southern Ghores and wadi Araba areas. Jordan is a mostly arid and semi-arid country; almost 90 % of the land area receives less than 200 mm of rainfall annually. This is reflected in its soils, in the land cover of range grasses and forest. Even within the higher rainfall areas, the annual variation and distribution fluctuates greatly.

The proposed project area is located in North of Jordan. According to the bioclimatic map of the country revised by Al-Eisawi (1985), the proposed project site is classified as Arid Mediterranean cool zone.

The climatic station that represents the project area is Mafraq climatic station which is located north west of the project area at a distance of about 12 km and is used for most of the climatic parameters. Table (5.1.1) presents the average monthly climatic parameters that were recorded for Mafraq climatic station for the long term period 1960-2011.

The climate is arid and hot in summer, with high daily temperature ranging from 16 to 33^{o}C. In winter low temperature varies between 2 to 12.7^{o}C with few occasional snows and frost days occurring mainly in January. The mean annual rainfall is about 221 mm occurring mainly from November to March. Rainwater harvesting is indigenous to the area serving animal husbandry and irrigation where the climate is Mediterranean climate that is characterized by a cold weather with temperatures that drops to -6C^{o}, the predominant prevailing wind from West and North West mainly occurring from March to August with almost no dust-storm or sandstorm. The yearly average wind velocity in Mafraq is 2.44 m/s.

Table 5.1.1: The average monthly climatic parameters that were recorded for Ramtha climatic station for the long term period 1976-2000

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly	Period
Mean maximum air temp. (°c)	13.5	15.1	19.8	24.6	29.0	32.5	34.0	33.9	31.7	27.8	20.8	15.4	24.8	2004-2013
Mean minimum air temp. (°c)	2.2	3.9	5.8	9.1	12.4	15.4	17.4	17.8	16.0	12.5	7.1	2.8	10.2	2004-2013
Total rainfall amount (mm)	32.8	32.5	8.8	4.9	1.4	0.0	0.0	0.0	0.1	4.5	18.0	16.9	119.9	2004-2013
Maximum rainfall amount in 24 hours (mm)	31.5	20.0	13.4	6.7	4.0	0.1	0.0	0.0	0.7	6.8	22.7	13.8	31.5	2004-2013
No. of dusty days (Vis.<= 5km)	2.8	3.2	5.3	5.2	4.8	4.6	3.8	2.1	1.2	2.6	1.7	1.6	38.8	2004-2013
No. of days with dust storm or sandstorm (vis. <= 1)	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.8	2004-2013
Mean relative humidity (%)	73.2	72.7	61.2	53.2	49.4	50.3	54.0	58.5	59.2	56.4	62.0	67.1	59.8	2004-2013
Mean wind speed `knot`	4.4	5.0	4.9	5.3	5.5	5.6	5.8	5.4	4.5	3.3	2.9	3.4	4.7	2004-2013

From the above table, the following could be concluded:

- **Temperature**: The average annual maximum temperature is 24.8^{o}C and the minimum temperature is 10.2^{o}C;
- **Relative Humidity**: the daily mean relative humidity ranged between 49.4 % in May and 73.2 % in January;
- **Wind**: The highest wind speed was recorded in July of 5.8 knot and the yearly mean wind speed was 73.2 knot in January;
- **Precipitation**: The average annual rainfall in Mafraq is estimated to be 119.9 mm. **Figure (5.1.1)** represents the isohytal map of Jordan including the project area.

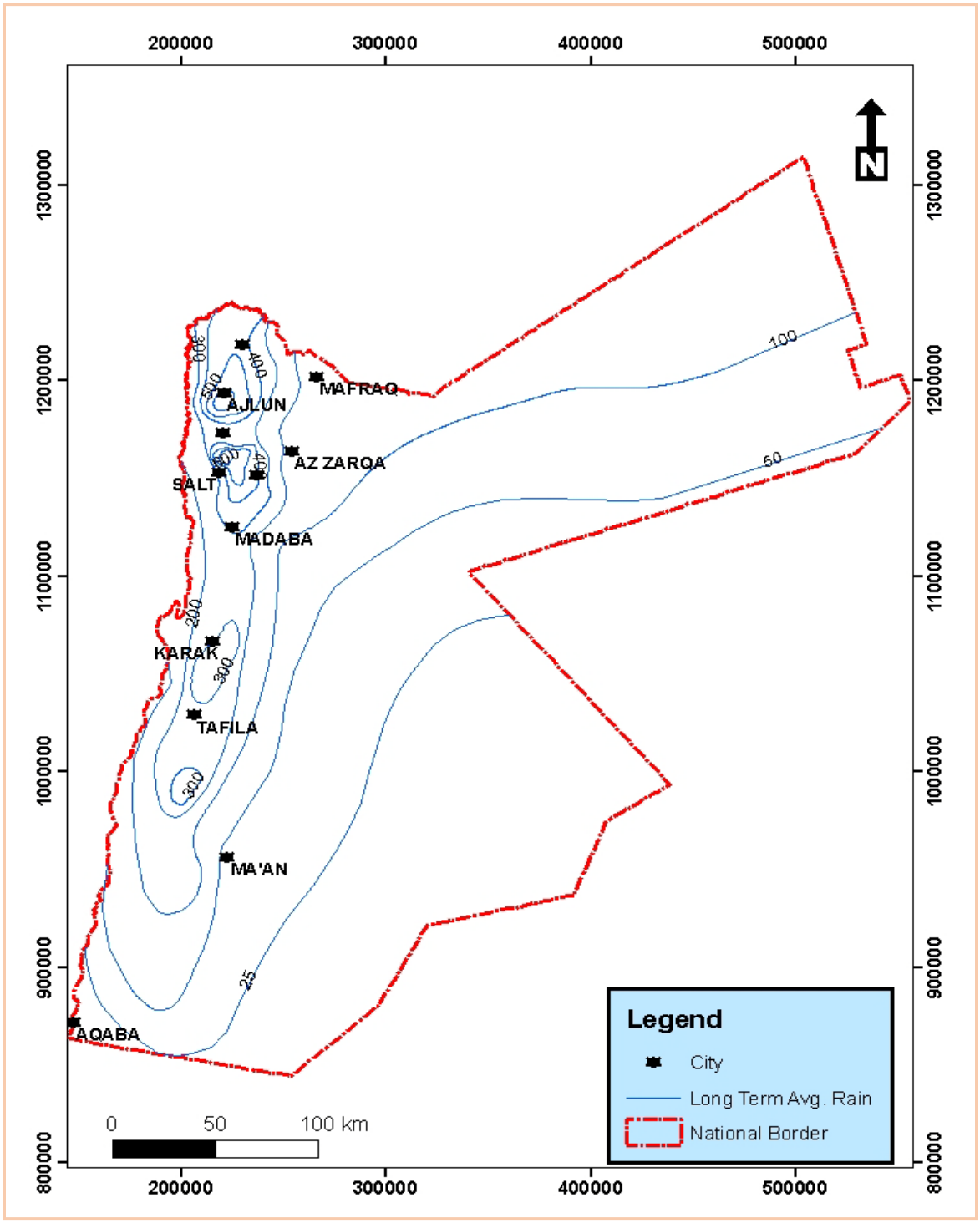


Figure 5.1.1: Isohytal Map of Jordan

5.1.2 Geology of the area

The project area including the proposed project site has groups of the geological formations consist of the superficial deposits, limestone deposits, marly limestone, chert and marl. The ages of these geological formations range between the recent and the upper cretaceous period.

These formations are affected by geological structures that have different intensity of effect. Figure (5.1.2) shows the geological map of the project area including the proposed PV plant project site and figure (5.1.3) represents the columnar section for the geological formations.

5.1.2.1 Geological formations

The study area comprises a two geological groups; **Ajlun Group** and **Balqa Group.** The first group is **Ajlun Group** which comprises the flowing formations.

Hummar Formation (A4) (Cenomanian)**:** The sedimentary rocks of the study area started with this formation, which consists of 40-55m of limestone grey to white, dolomitic limestone and dolomite varies in thickness. This formation is distributed in the south western of Mafraq area. The depositional environment of this formation is intidal to subtidal marine.

Shu'ayb Formation (A5) (Cenomanian to lower Turonian): the thickness varies from 50-60m in the Mafraq area. It consists of alternating of marly limestone, marl and limestone. It is dominated by the yellow colour, thin bedded and nodular texture in some levels. The environment of deposition is moderate to shallow marine.

Wadi Es Sir Limestone Formation (WSL) (Turonian)**:** this formation is considered as the top of **Ajlun Group,** it is well exposed in the Mafraq area especially in the south west, west and central parts of Mafraq area. The thickness ranges from 90-110m. It consists of five units as found in Wadi az Zaghrut. First unit consists of white massive limestone cliff-occurring on the boundary between Shu'ayb Formation and this formation. Second unit consists of 4-5 cycles of coquinal limestone, the thickness of each one may reach 1m. Third unit is the marl unit which consists of alternating of marl and marly limestone with yellow colour. The fourth unit is the chert unit which is alternating of limestone and chert beds or nodules. The last unit is crystalline limestone varies in thickness and have a good economic value for building and decoration stone. Macrofossils are very clear in this formation in some beds. The environment of deposition is shallow marine platform within tidal to lagoonal regimes.

The second geological group in the study area is **Balqa Group** which consist the following formations:

Wadi Umm Ghudran Formation (UMG) (Conacian-Santonian): this formation is the base of the Balqa Group and is lying unconformably above Wadi es Sir Limestone Formation. Its thickness is about 10m and exadurated. It consists of massive, chalk white in addition to chalky limestone and some marl. The depositional environment is mid to inner shelf.

The Amman Silicfied Limestone and Al -Hisa Phosphorite Formations (Santonian-Campanian): These two formations are considered as one unit in the area. The total thickness of this unit is about 15m; while the thickness of the Al Hisa phosphorite is about 20m. The unit consists of alternating of micritic limestone with chert varies in thickness in addition to alternating of phosphatic chert, phosphatic limestone with chert and phosphate. In this unit, the micritic limestone percent is increasing towards the top. The depositional environment is marine shelf.

Muwaqgar Chalk Marl Formation (Maestrichtian to lower Palaeocene): Its thickness ranges from 80-90m distributed in the northwest, central north and northeast of parts of Mafraq area. It consists of massive chalk marl grey to white full of microfauna; in this formation chert beds may present also. Crystalline limestone is present in the upper part, limestone concretions on the boundary between this formation and the overlay Umm Rijam Chert Limestone formation also present.
The glauconite, phosphate and gypsum veins may present locally at the upper part of the formation. The depositional environment is shallow marine.

Umm Rijam Chert Limestone Formation (Palaeocene to middle Eocene): The thickness of this formation is about 90m, it consists mainly of alternating of limestone, marl and chalk with chert varies in thickness. This formation started with 5-15m of limestone, marl and chalk, and then the chert beds appear. The large micritic limestone concretions are present at the top of this formation. The depositional environment is nearly deep marine.

Superficial deposits

i. **The calcrete:** Is characterized by low thickness and located in the north western part of the Mafraq area.

ii. **Plateau gravels**: (Pleistocene-Recent) consists of heterogeneous mixture of gravels with different sizes, from 1 cm to 1 cm.

iii. **Soil:** Mainly two types of soils are present, the red soil "Terra rosa" the Mediterranean Sea soil found in the south west and central of Mafraq area. The desert soils, yellow mostly mixture aeolian sands located northeast, east and southeast of Mafraq City.

5.1.2.2 Structural Geology

This area is dominated by two main fault systems, they are:

a. Northeast- southwest system is crossing the whole Mafraq area.
b. East-west system is crossing also the whole Mafraq area.
c. The Sirhan Fault System is crossing the area but it's covered mainly by superficial deposits.

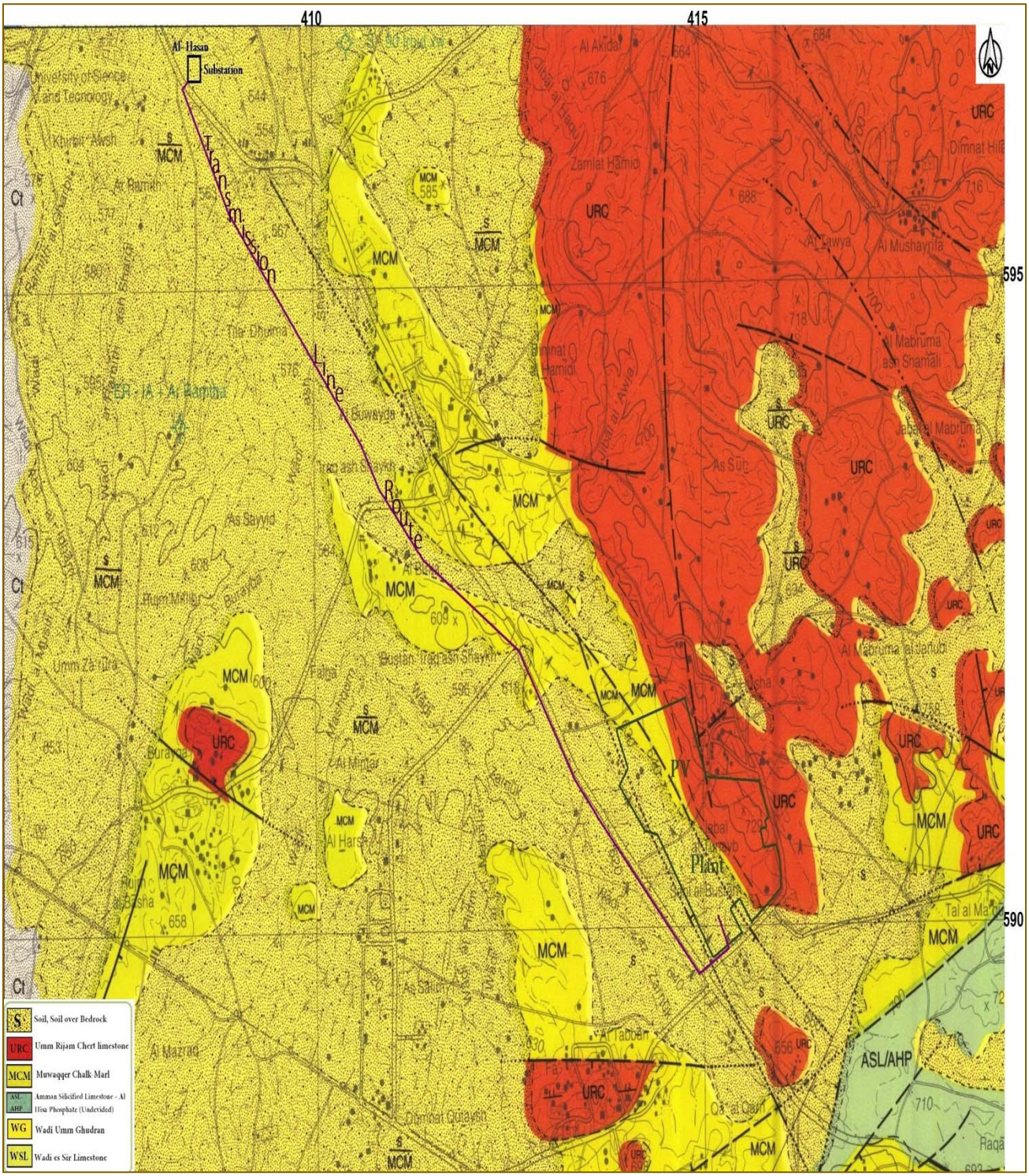


Figure 5.1.1: the geological map of the project area

5.1.3 Soil

AL Mafraq region is situated on the North-East Basalt plateau. One of the important characteristic of the region is the shallow soil depth. According to a study done by "Jordan Soils and Land Management", the Mafraq soil is classified as fine, mixed, calcareous, thermic family of Xerochreptic Paleorthids (USDA 1990) with a surface stone cover of 30%. The Soil geology is igneous basic: Basalt/Limestone from Calcrete parent material with a slow surface runoff. Soil surface condition is dry/soft with a well soil drainage class. Major soil erosion causes are wind, water, overgrazing and poor rainfall distribution resulting in desertification.

5.1.4 Water Resources

The rainfall in Jordan is the main source of its water resources (surface and ground water) including the proposed project area. The surface water resources in the area are the surface discharge in the wadis during the rainfall periods, while the groundwater is the water that occurs in the aquifers due to rainfall water percolation in the groundwater recharge mounds. Following is the description of these resources.

5.1.4.1 Surface water

Surface water runoff is defined as the runoff water which usually flows in the streams and Wadies during the rainy period in addition to the base flow which comes from the aquifer as springs and seepages when exist. **There is no base flow or springs in the project area**.

Husha and Ramtha area are located in the upper reaches of Yarmouk basin that has an extension to the Syrian lands all over the northern and north western part in Jordan. According to the hydrological data and the geological formations in the project area, the study team concluded that the surface water flow is normal to occur in the area when the rainfall amount exceeds 8 mm during the rainy days.

To study the effect of the activities of the proposed project on the surface flows (floods) in the project area, particularly, in the PV plant component of the project as the transmission line route covers lands very small areas, although it extends along 13 km.

However, it is necessary to calculate the maximum flood that may generate in the project area due to high and intense rainfall in the project area including project site. This water may flush and drain the pollutants (if any exists) that may be generated due to the project activities. The quantity of the runoff water is calculated using NRCSCN approach and the rainfall data of Mafraq climatic station.

When calculating the maximum rainfall quantity on the proposed project site and its catchment area, the records of the maximum rainfall of 24 hour at Mafraq climatic station which represents the proposed project area during the long period (2004–2013) were used; the recorded maximum rainfall quantity during 24 hours for this long period was (45.9 mm). To compute the maximum runoff caused by the maximum rainfall during 24-hr; the natural resources conservation services curve number approach was used as follow.

$$\mathbf{Q= \frac{(P-Ia)2}{(P-Ia+S)}}$$

Where:

P: is the maximum rainfall quantity (45.9 mm) during 24 hours for a long period including (cumulative rainfall);

Ia: is the initial abstraction before bonding (inches);

Q= is the runoff (inches);

S: is the max soil water storage potential (inches); **S= (1000/CN) – 10), S** was calculated based on the curve number CN which was determined according to hydrological group of the soil cover.

CN: is the curve number, which depends on the topography of the project area landscape and soil texture. Table (5.1.2) shows the Hydrologic Soil Group (HSG), while table (5.1.3) shows the runoff curve number;

Table 5.1.2: Hydrologic Soil Group (HSG)

Runoff curve numbers for hydrologic soil cover			Hydrologic Soil Group			
Land Use	**Treatment or Practice**	**Hydrologic Condition**	**A**	**B**	**C**	**D**
Pasture or Range	Natural	Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
		Fair	25	59	75	83
		Good	6	35	70	79

Table 5.1.3: Runoff Curve Number

Soil Group	Description	Final Infiltration Rate (mm/hr)	Soil Texture
A	Lowest runoff potential, Includes deep sands with very little silt and clay , also deep , rapidly permeable loess	8-12	Sand, Loamy sand, sandy Loam
B	Moderately low runoff potential .Mostly sandy soils less deep than A, and loose less deep or less aggregated than A, but the group as a whole has above – average infiltration after through wetting	4-8	Silt loam , Loam
C	Moderately high runoff potential. Comprises shallow soils and soils containing considerable clay and colloids, though less than those of group D. The group has below – average infiltration after presaturation	1-4	Sandy clay Loam
D	Highest runoff potential. Includes mostly clays of high swelling percent, but the group also includes some shallow soils with nearly impermeable sub horizons near the surface.	0-1	Clay loam, silty clay , Loam , sandy clay , silty clay , clay

The proposed project site is part of Wadi Al Zarnouk which drains the PV plant site towards wadi Al Rmaith in Ramtha area.

From the above equation, the maximum runoff is calculated as:

P = 45.9 mm;

S: Calculated from CN; which is also calculated from the Hydrologic Group and soil texture;

CN: 75

$$S = \frac{1000}{CN} - 10 = 3.33 \text{ inch X } 25.4 = 84.66 \text{ mm}$$

From which, **Ia = 0.2 S = 0.2 X 84.66 mm = 16.93 mm**

$$Q = \frac{(P-Ia)2}{(P-Ia+S)} = \frac{(45.9-16.93)2}{(45.9-16.93+84.66)} = \frac{839.3}{113.63} = 7.38 \text{ mm}$$ on each square meter

The proposed project comprises a surface area of about 1400 dunum. The volume of the runoff formed from the maximum rainfall during 24 hours on the proposed project site V in cubic meter is:

$$V = 0.00738 \text{ X } 1400000 = 1033.2 \text{ m3} = 0.0013 \text{ MCM}$$

The maximum runoff from the proposed project site is calculated to be **0.0013 MCM**.

The maximum flood flow (V) for the catchment area of Wadi Al Zarnouk, which has a surface area of about **30 km^2** is

V= 15,500,000 X 0.00738= 221400 m^3 **= 0.221 MCM**

5.1.4.2 Hydrogeologic Framework

The occurrence and the movement of Groundwater in general are governed by the geology (formation and structure), in addition to the topography of the area. Jordan is characterized by the development of a rather complex hydraulic system with considerable difference in ground water head and inflow directions in large parts of northern and central Jordan. For practical purposes, the sequence of aquifers and aquitards has been divided in to the following hydraulic complexes of regional importance:

- The shallow (Upper) aquifer system (Alluvium , B4-B5, basalt)
- The upper cretaceous A7/B2 limestone aquifer
- The deep sandstone aquifer system (formed by the Paleozoic Rum Group , including the Disi formation , and the lower cretaceous sandstone)

The sedimentary rocks of upper cretaceous which are known as Amman wadi Es-Sir aquifer (B2/A7) is the main source of water in Mafraq area; this aquifer consists mainly of limestone and chert. The lower part of basalt flows that overlaid B2/A7 aquifer is also considered as an aquifer if it is located within the groundwater saturation zone. However, all the conducted hydrological studies on the northeastern part of Jordan concluded that a hydraulic connection between B2/A7 and basalt aquifers exists.

Unfortunately, the B2/A7 aquifer in the project site is located above the groundwater saturated zone, which means the B2/A7 in the site is not an aquifer. While this unit in Sama Al Sirhan and Smaya areas which are located to the east and north east of Husha area is within the groundwater saturated zone and forms good aquifer.

According to Al Shamil Engineering's experience in the area, and due to the presence of the proposed PV plant within Yarmouk ground water basin, we could say that no ground water exists in Husha area down to the depth of 400 m. for this reason, the current water supply for Husha area is coming from the groundwater in north eastern Badiah (Amman- Zarqa groundwater basin) through the public network of Water Authority. Consequently and given that the technology used in the project is PV, water consumption is expected to be less than 12 m^3 by using dry cleaning method. However, the hydrological data obtained from drilled wells in the Sama Al Sirhan and Smaya areas are presented in the table (5.1.4).

Table 5.1.4: List of the drilled water wells in the area surrounding the project area

IDN	PGE	PGN	ALT	TD	Yield	DD	Salinity	Unit
AD 1000	260120	209230	616	217	55	10.56	486	B2/A7
AD 1001	259560	208860	620	263	50	0.3	480	B2/A7
AD 1002	259175	213545	613	250	57	0.23	506	B2/A7
AD 1003	258240	208515	648	390	25	156.49	435	B2/A7
AD 1004	258895	208890	638	260	15			B2/A7
AD 1005	258895	208890	642	328	43	41.3	493	B2/A7
AD 1006	258590	213870	642	250	80	3	530	B2/A7
AD 1007	257335	210335	651	300	50	3.68	506	B2/A7
AD 1009	258300	212850	630	352	80	0.3	528	B2/A7
AD 1010	257870	212560	678	352	70	38.80	553	B2/A7
AD 1012	264018	210565	590	205	32	32.22	633	B2/A7
AD 1013	263740	205470	615	306		64.1	640	B2/A7
AD 1018	261060	205105	658	300	22	30.32	540	B2/A7
AD 1019	260355	208190	618	239	38	36.2	460	B2/A7
AD 1060	261010	211870	592	225	43	19.23	602	B2/A7
AD 1061	259910	213485	624	223	62	3.98	505	B2/A7
AD 1151	248765	220182	536	190	32	46.1	708	B2/A7
AD 1152	253380	206790	756	234	N.A	N.A	N.A	B2/A7
AD 1153	253390	206415	715	210	N.A	N.A	N.A	B2/A7
AD 1154	253280	207240	719	200	N.A	N.A	N.A	B2/A7
AD 1155	257150	207700	680	307	10	22.05	N.A	B2/A7
AD 1156	252389	202123	716	295	12	N.A	634	B2/A7
AD 1158	253369	198927	768	200	N.A	N.A	N.A	B2/A7
AD 1159	240248	218401	514	495	45	46	704	B2/A7
AD 1168	249300	215527	559	425	45	16.35	534	B2/A7
AD 1169	249950	214000	558	428	36	104.68	534	B2/A7
AD 1170	248433	211302	560	412	10	N.A	796	B2/A7
AD 1171	249783	220176	561	212	30	59.07	758	B2/A7

5.1.4.3 Ground water recharge

The recharge to the main aquifer B2/A7 in Sama Sirhan and Smaya areas east to Husha area is considered to be indirect as this aquifer is not exposed in the recharge area, which is located in the Syrian territories where the average annual rainfall exceeds 400 mm. the rock exposure in the recharge area is basalt that overlain the B2/A7 aquifer and is characterized by high porosity and permeability; these conditions make the two aquifers in hydraulic connection. Under these conditions, the water flows from the basalt to (B2/A7) aquifer vertically and laterally. As a conclusion, we could say that jabal Al Arab in Syria is the recharge area for the ground water in these areas.

Figure (5.1.3) presents the ground water regional map. According to this map, the ground water flow direction is from the Syrian lands to the Jordanian lands, where it is distributed to the water basins in Jordan (Azraq , Zarqa and Yarmouk basins).

The groundwater regional map indicates that the proposed project site is almost located within the Upper reaches of Yarmouk basin and has no ground water occurrence in the limited aquifer (B2/A7). However, the hydraulic parameters of the Amman – Wadi Es.Sir aquifer (B2/A7) such as hydraulic conductivity make this aquifer of good yield and of good quality of water.

5.1.4.4 Groundwater Quality

According to water Authority reports and data, which is obtained from the ground water quality monitoring programs in the Mafraq area including Sama Aserhan, the water quality is considered to be generally good, and suitable for all purposes (drinking, irrigation and industrial uses) as indicated from the water salinity that ranges between 435-796 ppm.

5.2 Biological Environment

Renewable energy such as solar energy has the potential to reduce environmental impacts caused by the use of fossil fuels to generate electricity. This is because, unlike fossil fuels, solar energy does not generate atmospheric contaminants or thermal pollution, thus being attractive to many governments, organizations, and individuals. However, it may have an adverse environmental impact if not monitored appropriately such as its anticipated effects on wildlife including birds. Therefore, the baseline data for the biological environment is of great importance to this study. This study is conducted according to the Jordanian regulations related to the biological environment, in addition to IFC applicable requirements.

This section of the EIA study includes flora, fauna and sensitive habitats in the area, the present status of the flora and fauna including the bio-geographical area of the proposed project is described. Furthermore, baseline data is collected, reviewed and analyzed to define the interaction between the biodiversity and the surrounding environment, and has been prepared to illustrate the expected effects of the proposed project on the habitat and species (flora and fauna), and to develop the required mitigation measures. The project area is part of the northwestern of Mafraq area and covers an area of about 1400 dunum.
The project is located within the Irano -Turanian Bio-geographical zone which is characterized by an annual rainfall ranges from 150-300 mm/year with poor soil.
Conducting the biodiversity baseline study is to achieve the following objectives:

- Identifying the floral and faunal species including birds composition in the project area;
- Identifying sensitive habitats which might occur in the project location; and
- Propose mitigation measures if necessary to ensure limiting the effects on the existing fauna and flora at the site.

5.2.1 Literature Review

Jordan is characterized by the presence of four major bio-geographical zones, each is distinguished by a particular climatic conditions which in consequence supported the presence of a variety of species of fauna and flora. The study area is located within the Irano-Turanian bio-geographical zone of Jordan and specifically within the steppe vegetation type. This zone was described extensively in the vegetation of Jordan book produced by Al Eisawi, 1996. However, some scientists are considering the Irano- Turanian zone as a marginal area which depends mainly on rainfall amount.

Boissier (1867-1988), published the Flora Orientalis which is considered as the highlight reference for the Flora of the whole region of the Middle East, including Jordan. This book added lots of the newly described species and the type specimens of the new species from the region are deposited in the herbarium at Geneva Botanic Garden, Switzerland. This book illustrated several species inhabiting the Irano-Turanian bio-geographical zone.

Zohary, (1962) in his book "Plant Life of Palestine" covered the majority of the literature related to the area until date. His work together with Feinbrun-Dothan (1966-1986) is presented in the major references of the "Flora Palaestina", and is considered the main reference to the flora of Jordan until this time. In 1973, Zohary published a major reference to the Middle East under the name Geobotanical Foundation of the Middle East, where he extensively wrote about the plant bio-geographical regions, and the major plant groups and formation in the whole area.

In 1973, a publication titled as "Geobotanical Foundation of the Middle East" was produced by Zohary and is considered a major reference to the Middle East floral species. This publication included extensive information about the plant bio-geographical regions, and the major plant groups and formation in the whole area.

Al-Eisawi (1982), published the List Vascular Plants in Jordan, where more than 2000 species were recorded. Since then, extensive number of papers related to the flora and biodiversity has been published. The first paper related to the vegetation of Jordan was presented in 1983 during the Conference of Jordan through History, present, past and future, which was held in Amman, Jordan.

The same work Al-Eisawi (1985), was edited by Haddidi, and published as a book of the proceedings. Later on this was developed into a major reference as book published by UNESCO under the title Vegetation of Jordan, Al-Eisawi (1996). This book described in details the vegetation and bio-geographic regions of Jordan. A new vegetation map for Jordan was produced and specific regions were discussed in particular such as the Irano-Turanian.

Disi et al. 2001 provided a comprehensive description for the reptiles and amphibians of Jordan in the atlas and field Guide: "Amphibians and Reptiles of the Hashemite Kingdom of Jordan". This guide provides extensive information about Herpetofaunal species, their bio-geographical affinity, systematic and a distribution map for each species was provided. The book stated several species inhabiting the Irano-Turanian bio- geographical region. This guide was followed by a second guide on reptiles and amphibians of Jordan produced by Disi, 2002. It described new species reported from Jordan and highlighted information about their status, distribution and systematic. This guideline includes notes on bio-geographical affinity of reptilian and amphibian's species of Jordan.

Although no particular studies on bats faunal diversity have been accomplished in the project area, but records of bats faunal diversity from the Irano- Turanian zone were described by Qumsiyeh et al. 1998 where he illustrated bay faunal diversity and their bio-geographical affinities. Amr and Disi (1988) published a report on the Jordanian Mammals Acquired by the Jordan University Natural History Museum. The report includes species, their status and the distribution in Jordan.

Harrison and Bates (1991) published the most comprehensive review on the Mammals of Arabia including Jordan. The book contains a list of all mammalian species from the Arabian Peninsula with a detailed description of all species' external characteristics, cranial measurements, dentition, variation, distribution in the range countries and some useful remarks on the biology of the species. His review stated records of mammalian species from the Irano- Turanian zone in Jordan.

Benda et al. (2010) published the most comprehensive and up to date manuscript on the bats of Jordan, including distributional data, ecology, echolocation, ectoparasites and zoogeographical analysis.

The proposed project site is far away from any established or proposed protected areas. In addition, no special conservation areas are located near or adjacent to the study area. However, the project will cross-over an Important Bird Area (IBA) which is Al Mafraq IBA. This area was identified in the year 2000 since it holds specific importance for resident and\or migratory species and contains threatened birds species. In addition, this site is a potential protected area if conservation measures were taken into consideration.

5.2.2 Proposed Project Location in relation to Bio-geographical Zones of Jordan

The project is located within the Irano -Turanian Bio-geographical zone (figures 5.2.1 and 5.2.2). This zone is considered as a transitional zone by some scientist since it depends on precipitation rate, but it is accepted by others as a separate zone. The Irano-Turanian is surrounding the Mediterranean region except in the North, and is typified by an annual rainfall ranges from 150-300 mm/year, the soil is poor and the altitude ranges from 400-700 meter above sea level (Al Eisawi, 1996).

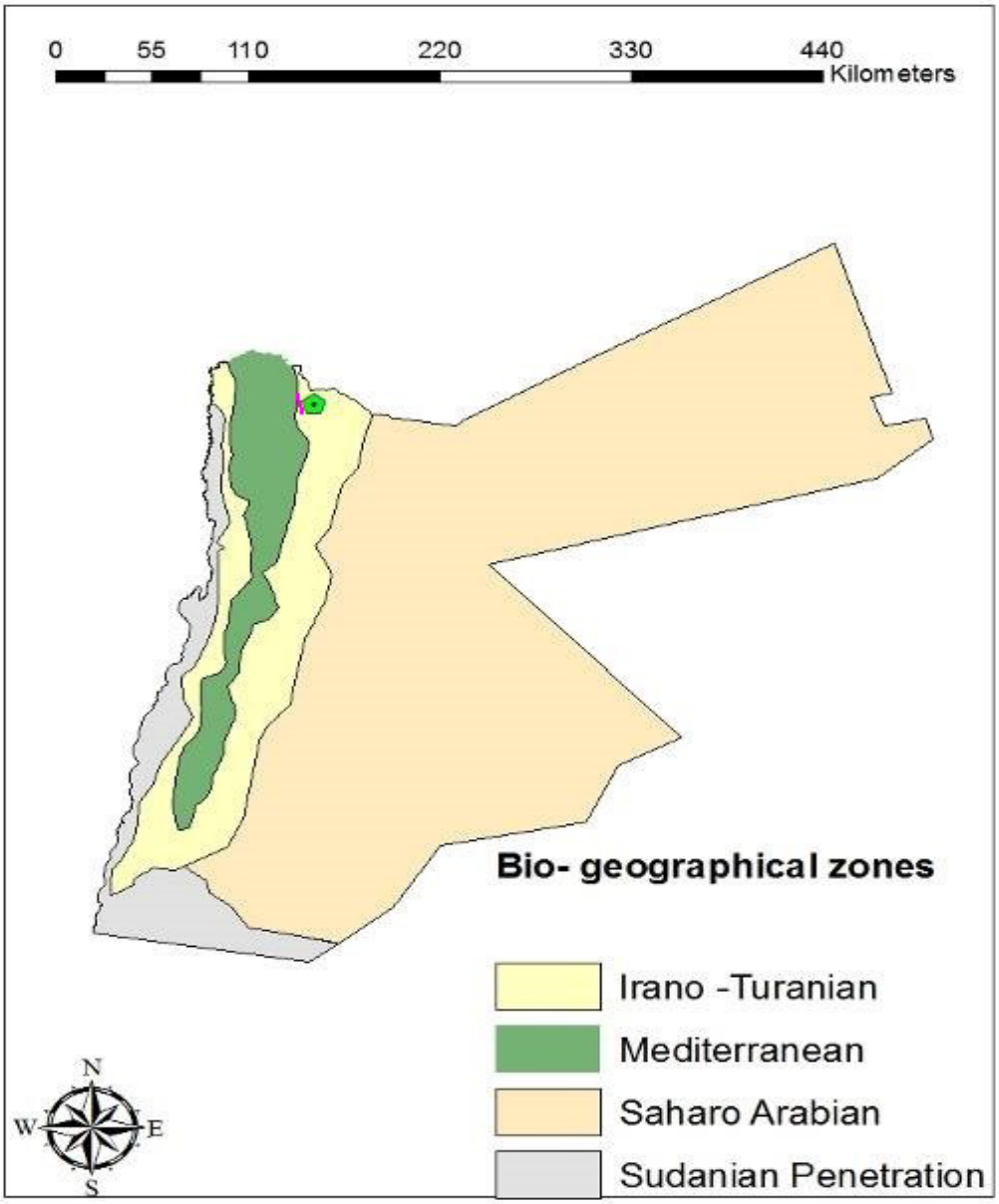


Figure 5.2.1: Project locations in relation to bio-geographical regions of Jordan

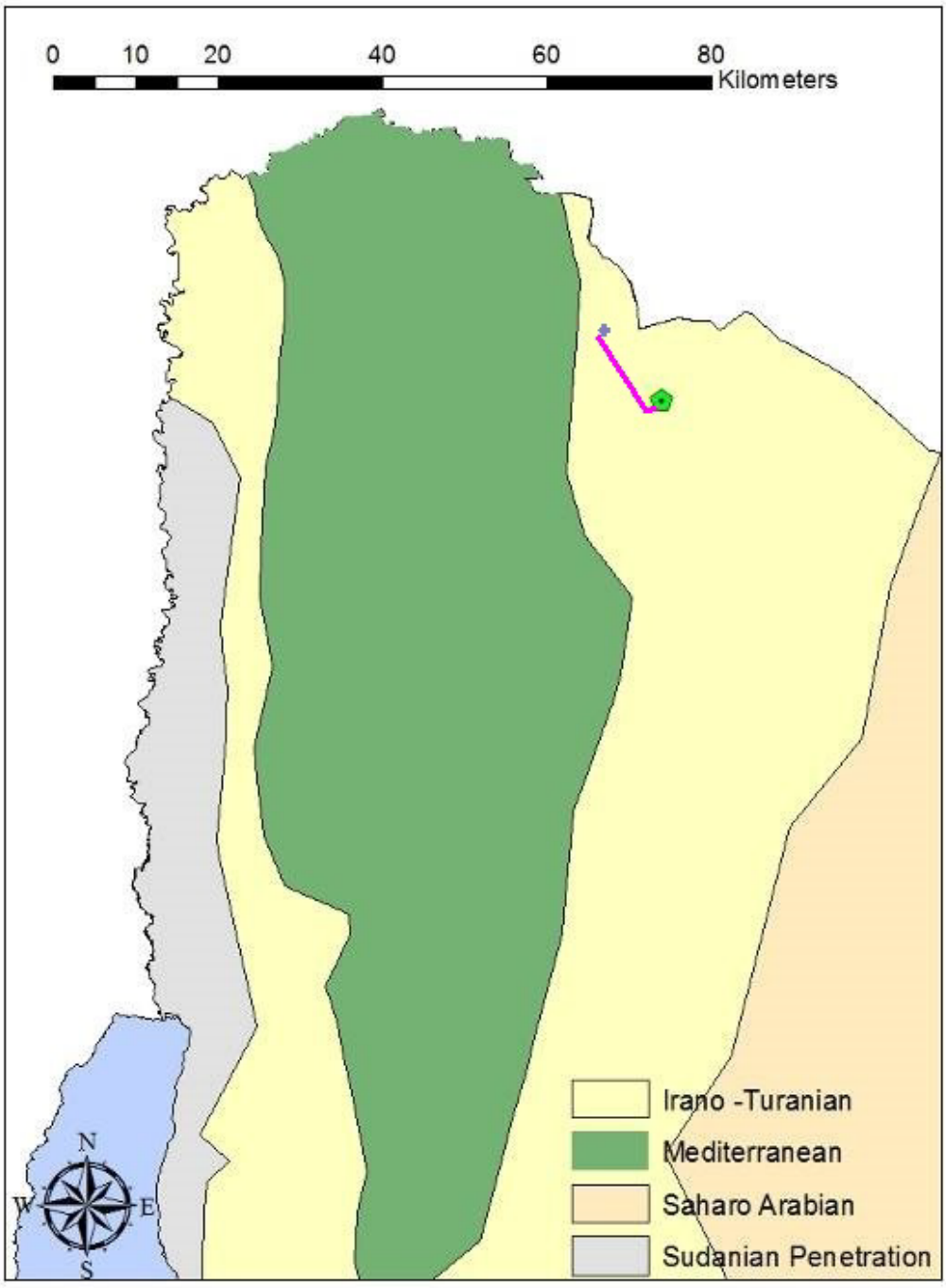


Figure 5.2.2: Closer image to the project location in relation to bio-geographical regions of Jordan

5.2.3 Proposed Project Location in relation to Vegetation Types of Jordan

The project is located within the open steppe vegetation type in Jordan (Al Eisawi, 1996). This type is dominated by dwarf shrubs and grasses, mostly belonging to the Irano-Turanian zone. The open steppe habitat in the project location generally appears as a homogenous mixture of flat areas with yellow steppe soils, dominated by perennial plant and annual grasses. Vegetation cover varied according to disturbance and includes Anabasis articulata species. Al Eisawi, 1996 described the expected vegetation that shall be present in this habitat if not disturbed with a dominated of Retama raetam, Ziziphus lotus, and Ferula communis (Figure 5.2.3 and 5.2.4).

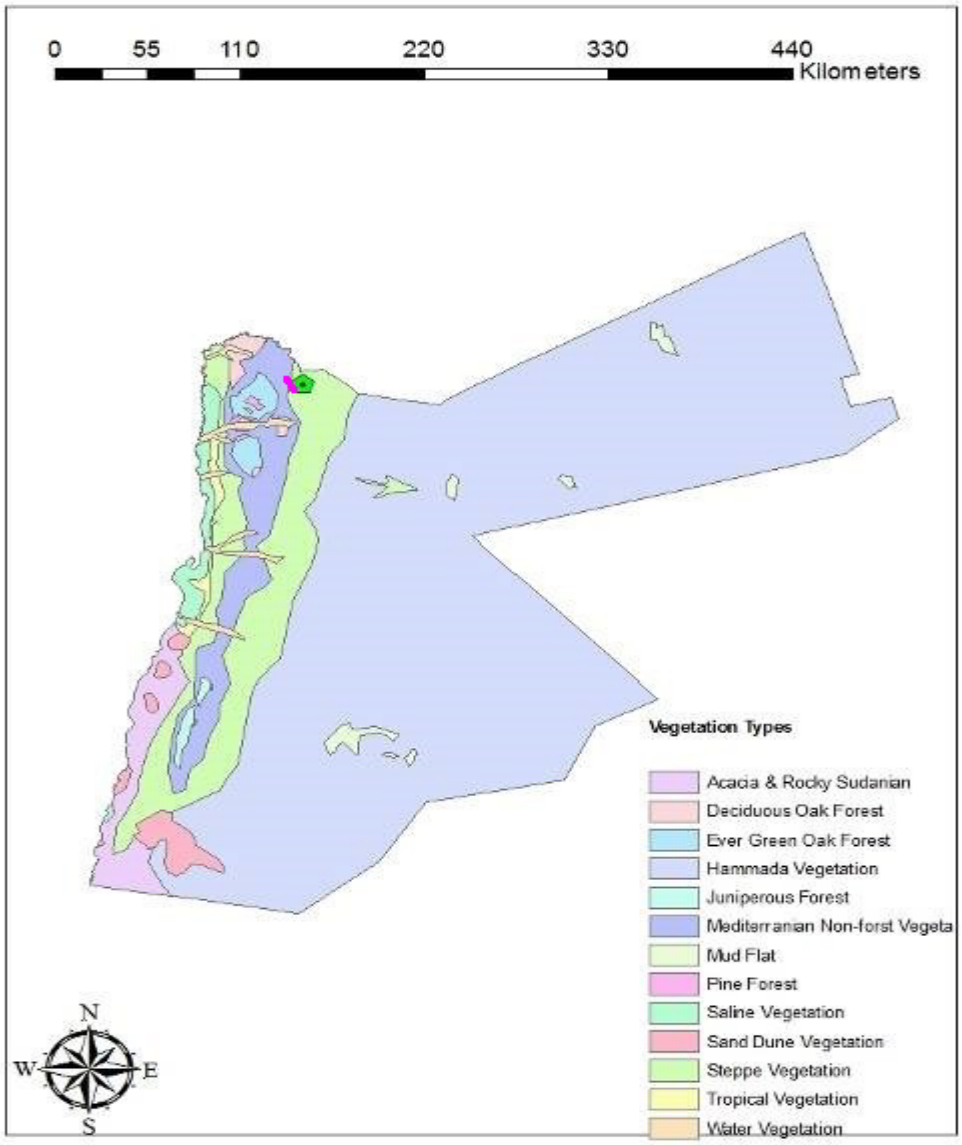


Figure 5.2.3: Project locations in relation to vegetation types in Jordan

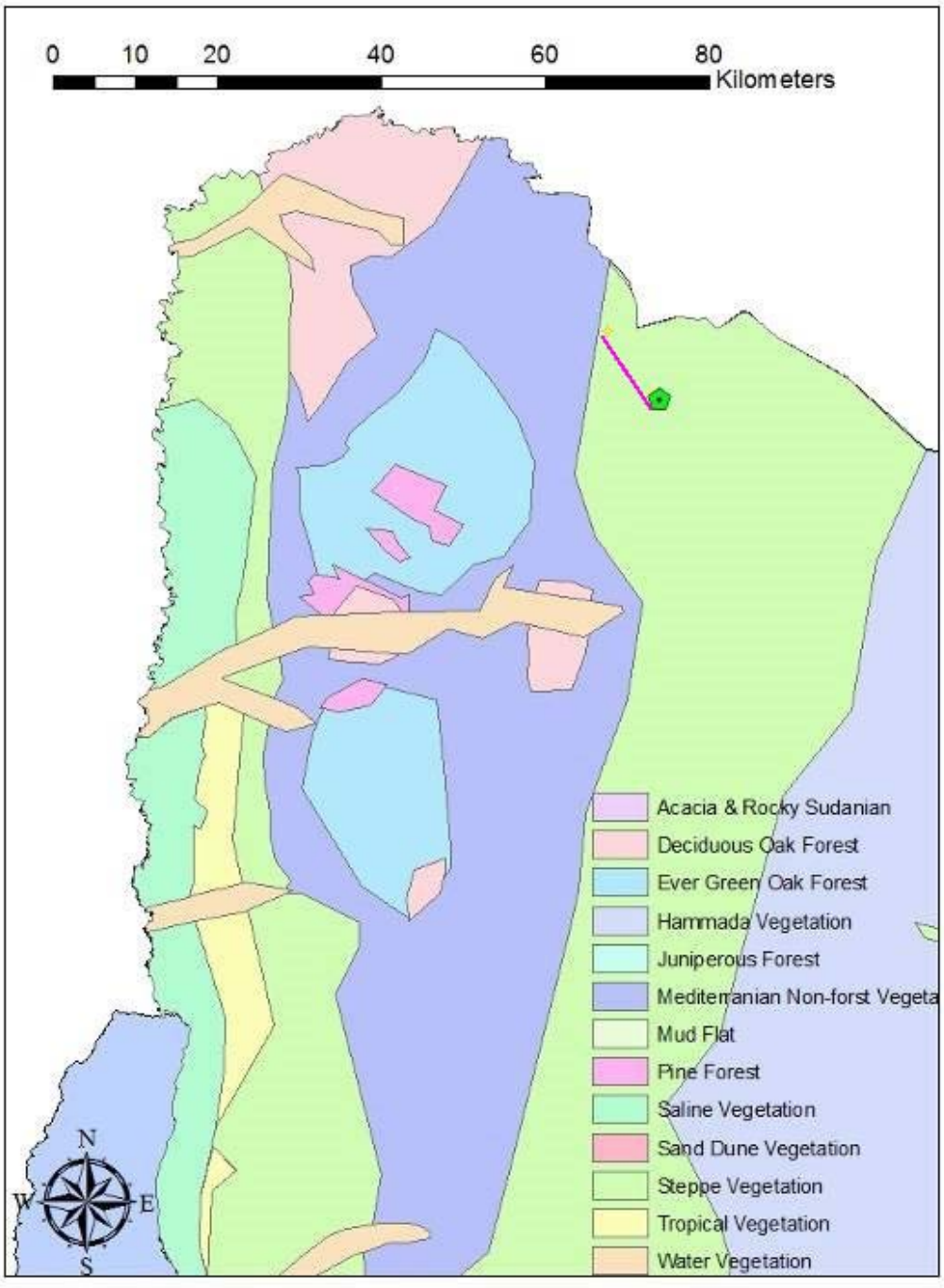
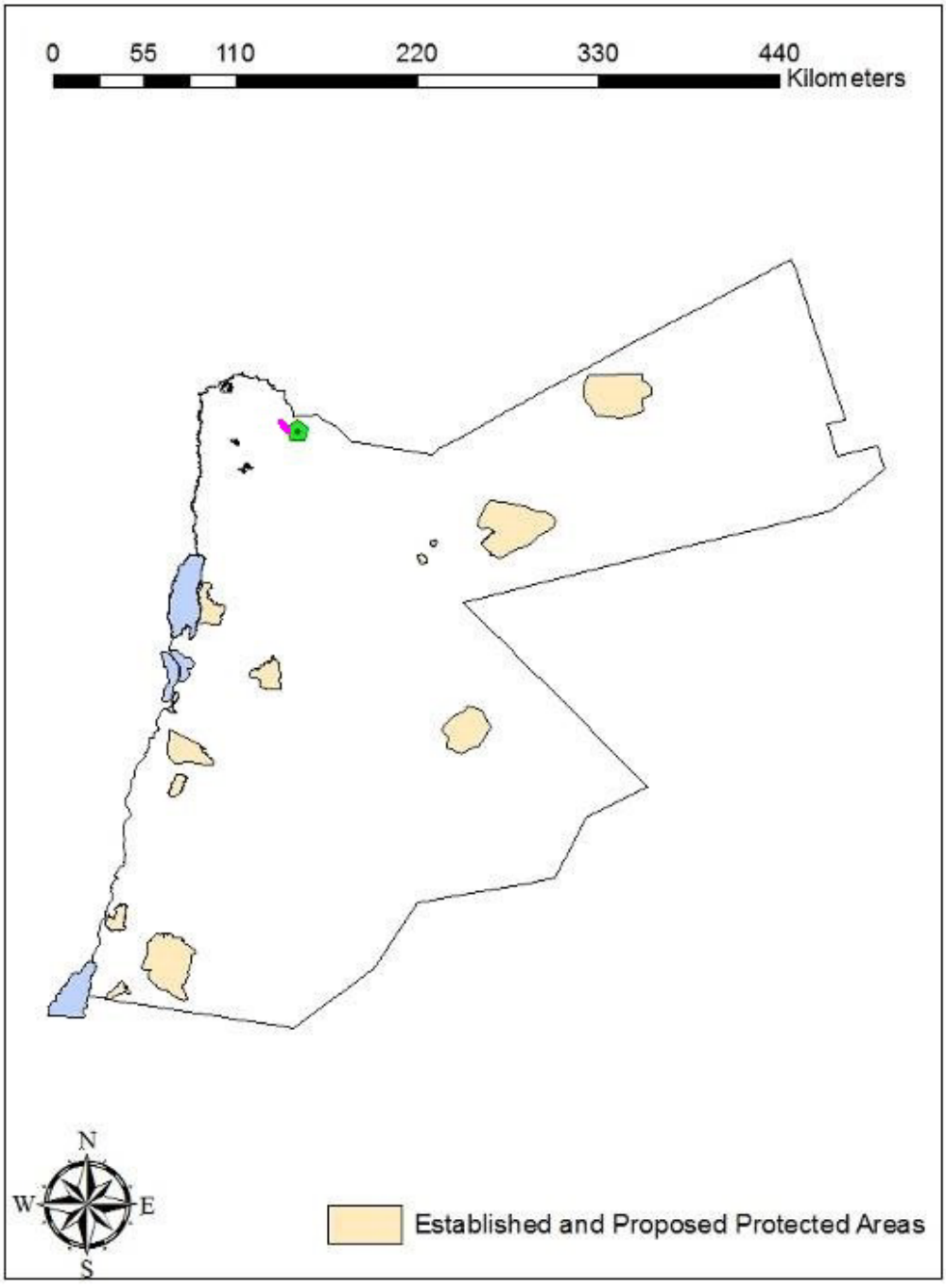


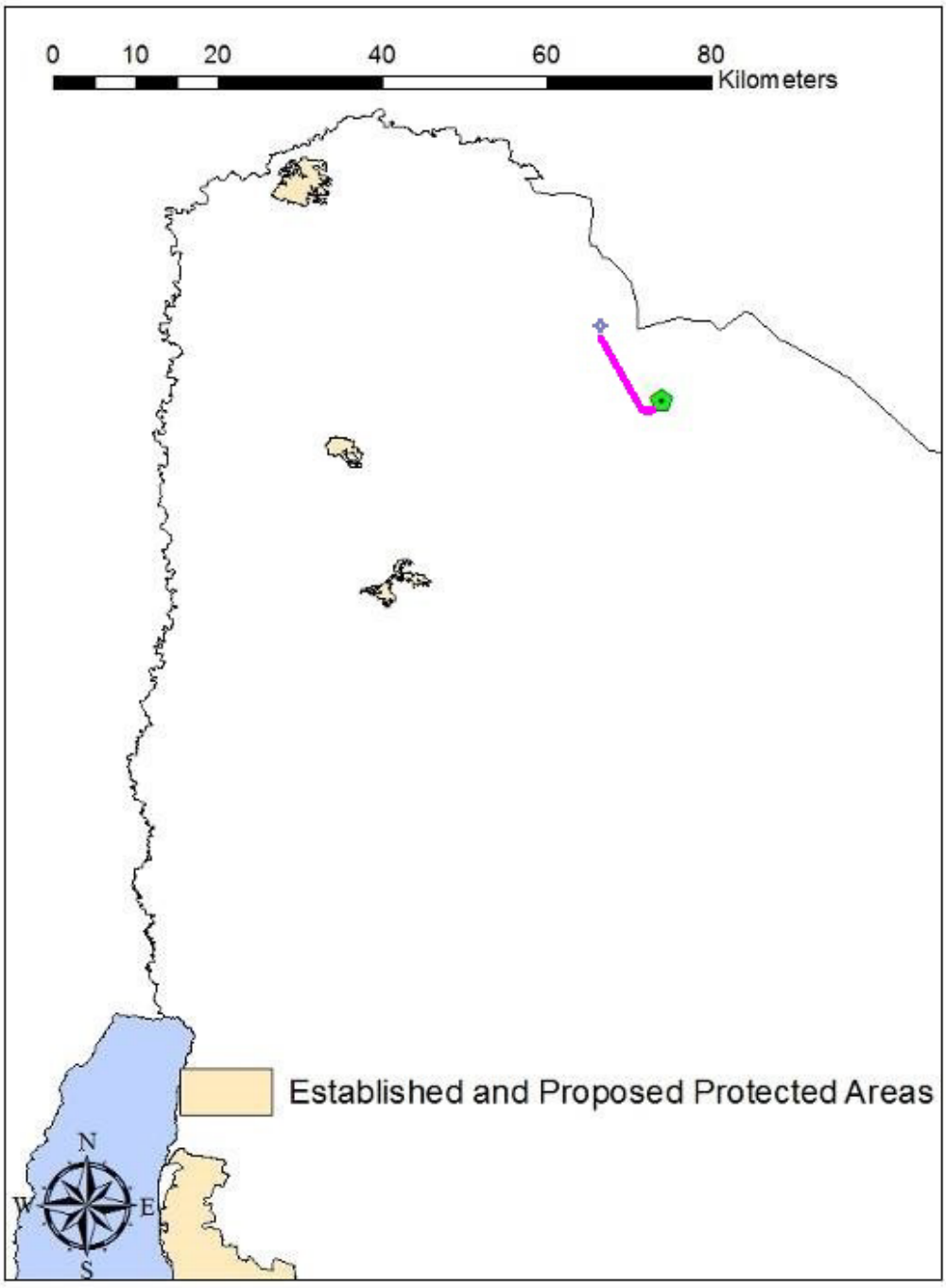
Figure 5.2.4: Closer image to the project locations in relation to vegetation types in Jordan

5.2.4 Proposed project location and its correlation to Jordan's conservation areas

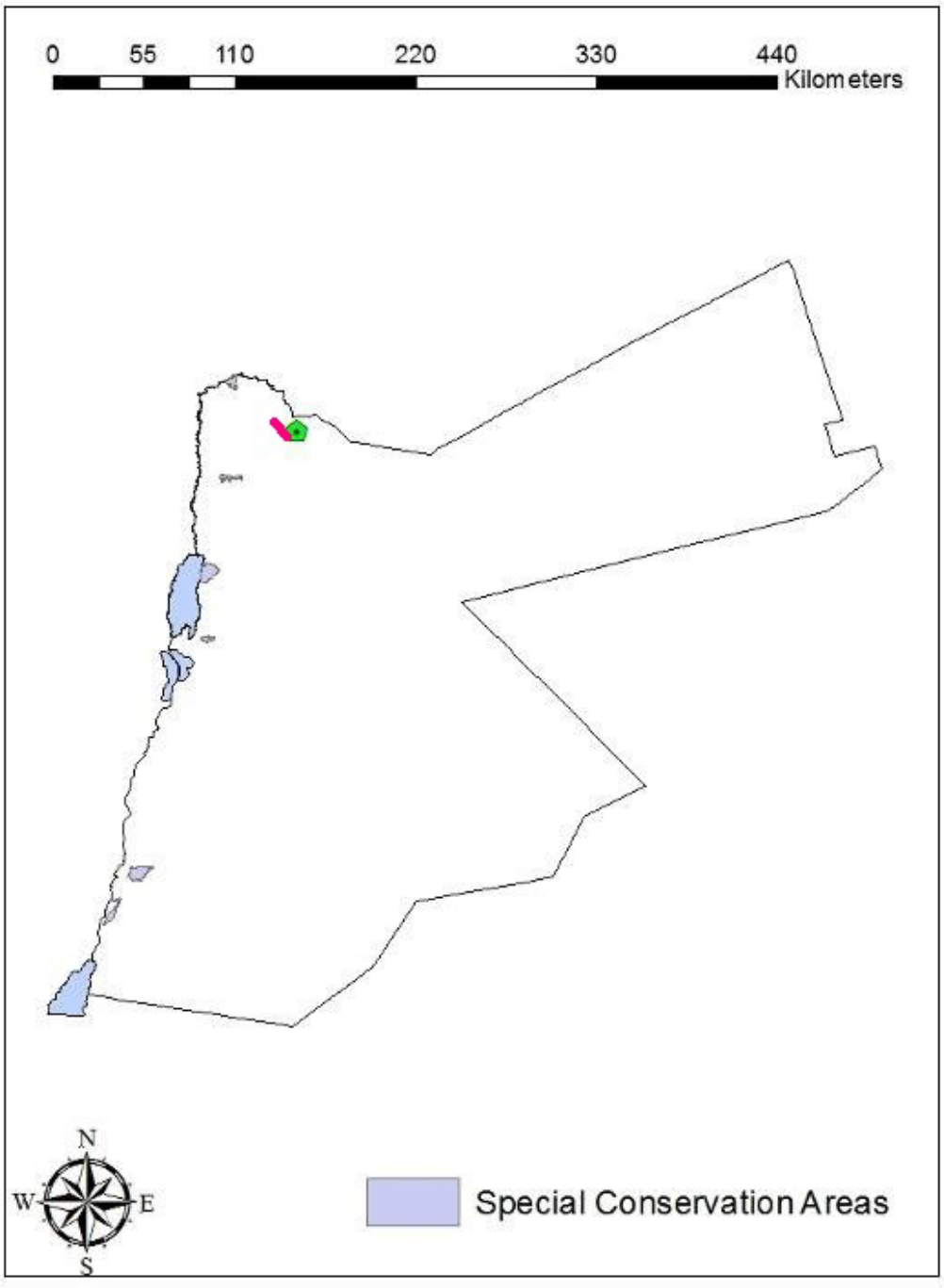
The project doesn't cross any established and\or proposed protected area which was published in the Jordan Network of Protected Areas book (RSCN, 2000) (Figures 5.2.5, 5.2.6). In addition, the project is away from any proposed or established special conservation areas (Figures 5.2.7, 5.2.8).



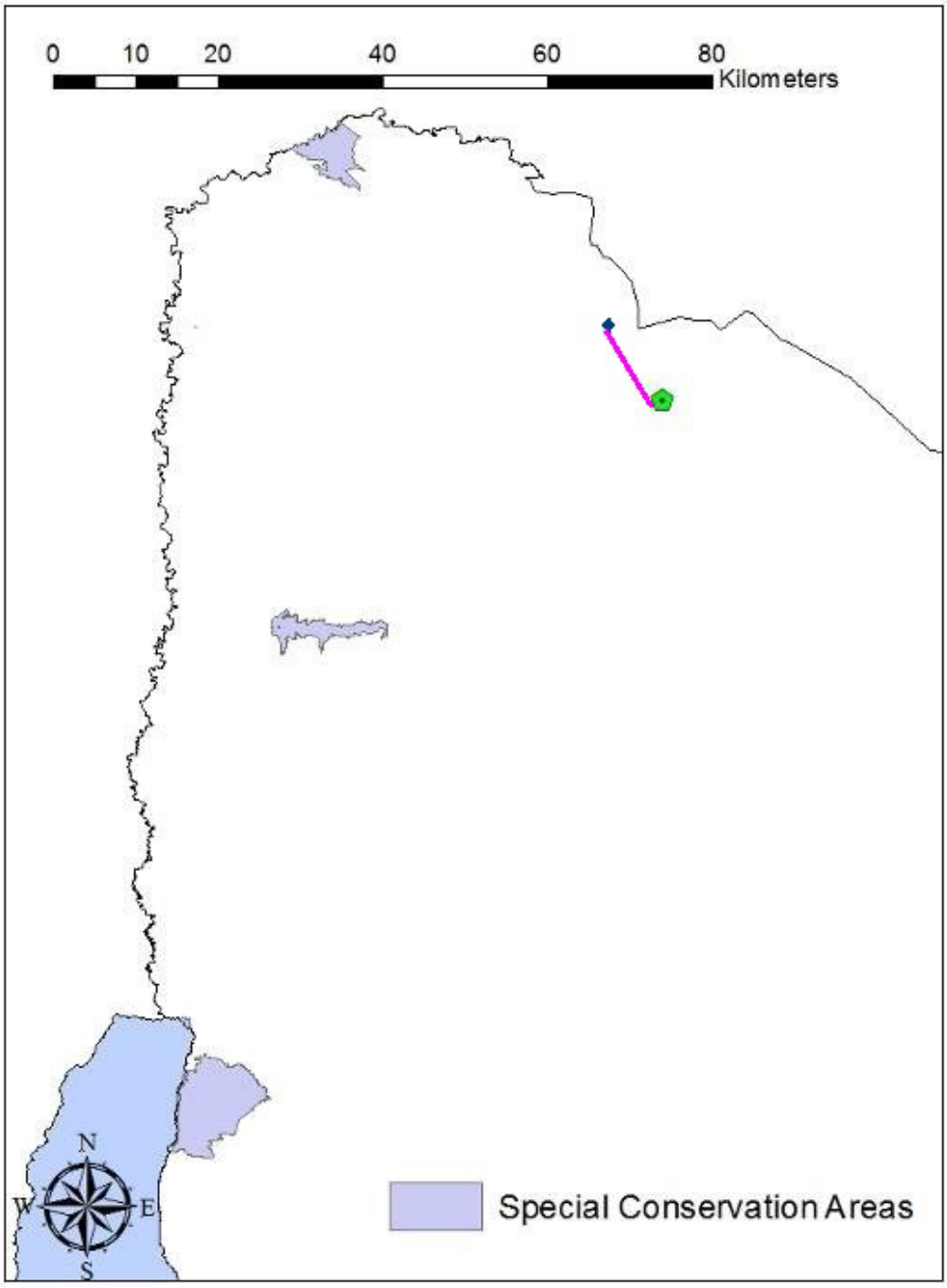
Figures 5.2.5: Project locations in relation to Jordan's protected areas



Figures 5.2.6: Closer image to the project locations in relation to Jordan's protected areas



Figures 5.2.7: Project locations in relation to Jordan's Special Conservation areas



Figures 5.2.8: Closer image to the project locations in relation to Jordan's Special Conservation areas

5.2.5 Project Location in relation to Jordan's IBAs

The project area is located near Mafraq Important Birds Area (IBA of Jordan, 2000). Norms and standards of the important birds area are not applicable for the project site. The project site was designated since it holds important birds species on the national and global level (Figure 5.2.9, 5.2.10).

Historically, the proejct site is located within Irbid- Mafraq plains Important Birds Area (IBAs) which was declared by the government of Jordan in 2000. This IBA was considered important for birds since it hosts the presence of threatened species of birds as represented in the table below.

Species name	Common name	Status
Buteo rufinus	Long-legged Buzzard	Least concern
Burhinus oedicemus	Eurasian stone-curlew	NA
Galerida cristata	Crested Lark	Least concern
Melanocorypha calandra	Calandra Lark	Least concern
Calandrella brachydactyla	Greater Short-toed Lark	Least concern
Athene noctua	The little owl	Least concern
Grus grus	The Common Crane	Least concern
Vanellus vanellus	The northern lapwing	Least concern
Alauda arvensis	Eurasian Skylark	Least concern
Aquila heliaca	eastern imperial eagle	Vulnerable
Falco naumanni	Lesser Kestrel	Least concern
Crex crex	Corn Crake	Least concern
Chettusia gregaria	Sociable Lapwing	Least concern
Gypus fulvus	Griffon Vulture	NA
Oenanthe finschii	Finsch's Wheatear	Least concern
Serinus syriacus	Syrian Serin	Vulnerable

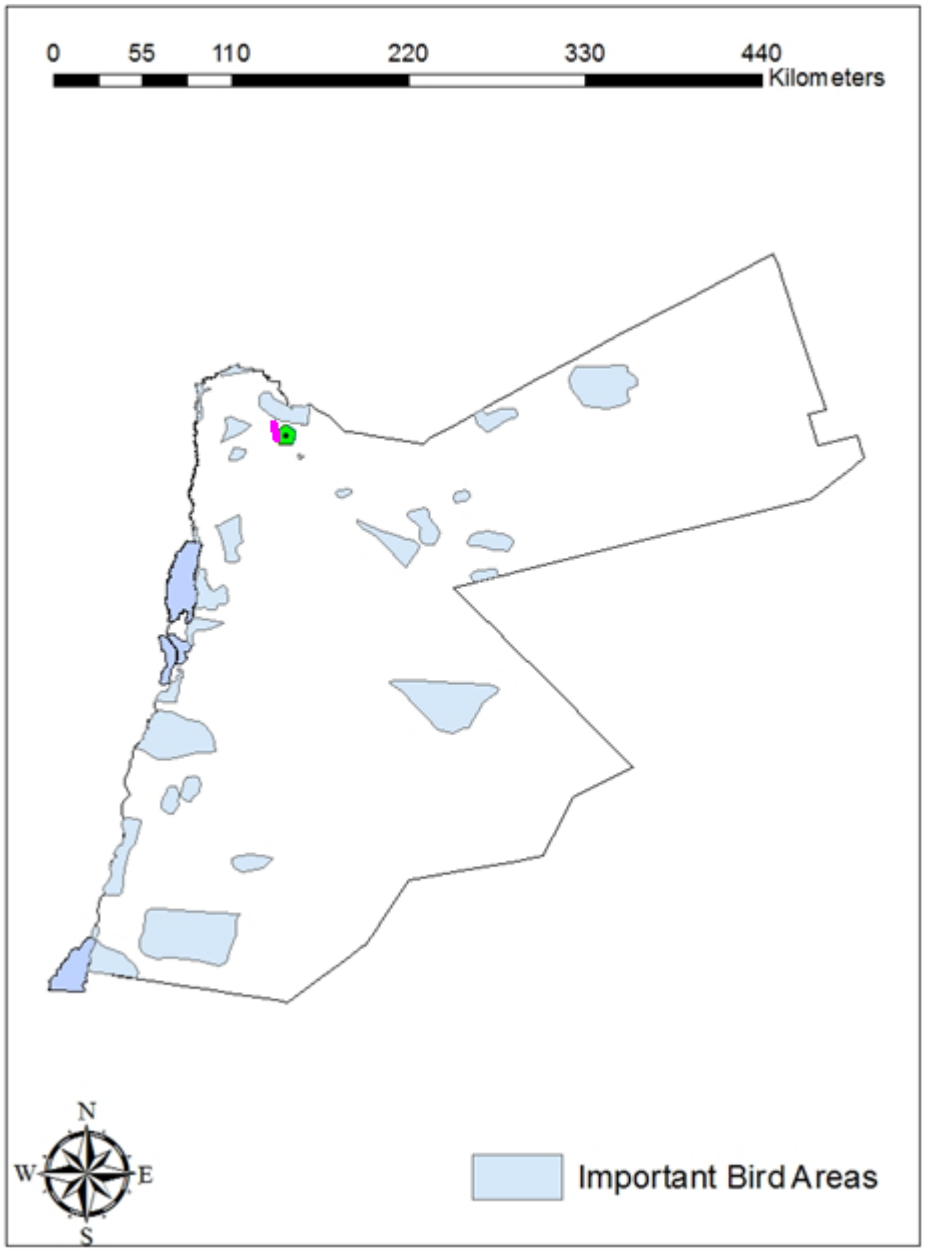
The biodiversity study team revised the location of the proposed project in relation to the Irbid-Mafraq IBA (desktop and field study); they found that the proposed project is located within the southern edges of Irbid-Mafraq IBA. As indicated in the following statement written by the biodiversity specialist:

> "Despite the occurrence of the project area within the southern edges of Irbid-Mafraq IBA, preliminary results show low significant values for birds species in the area, this is mainly due to food and water scarcity at the site, location within residential areas, the presence of factories surrounding the area and the heavy traffic on Mafraq-Irbid road that crosses over the Mafraq IBA. Moreover, the IBAs of Jordan book which was published in 2000 mentioned the urgent need to regulate grazing, stop urbanization, and encourage local people to adopt friendly agricultural practices to the environment. However, the study showed that nothing was achieved

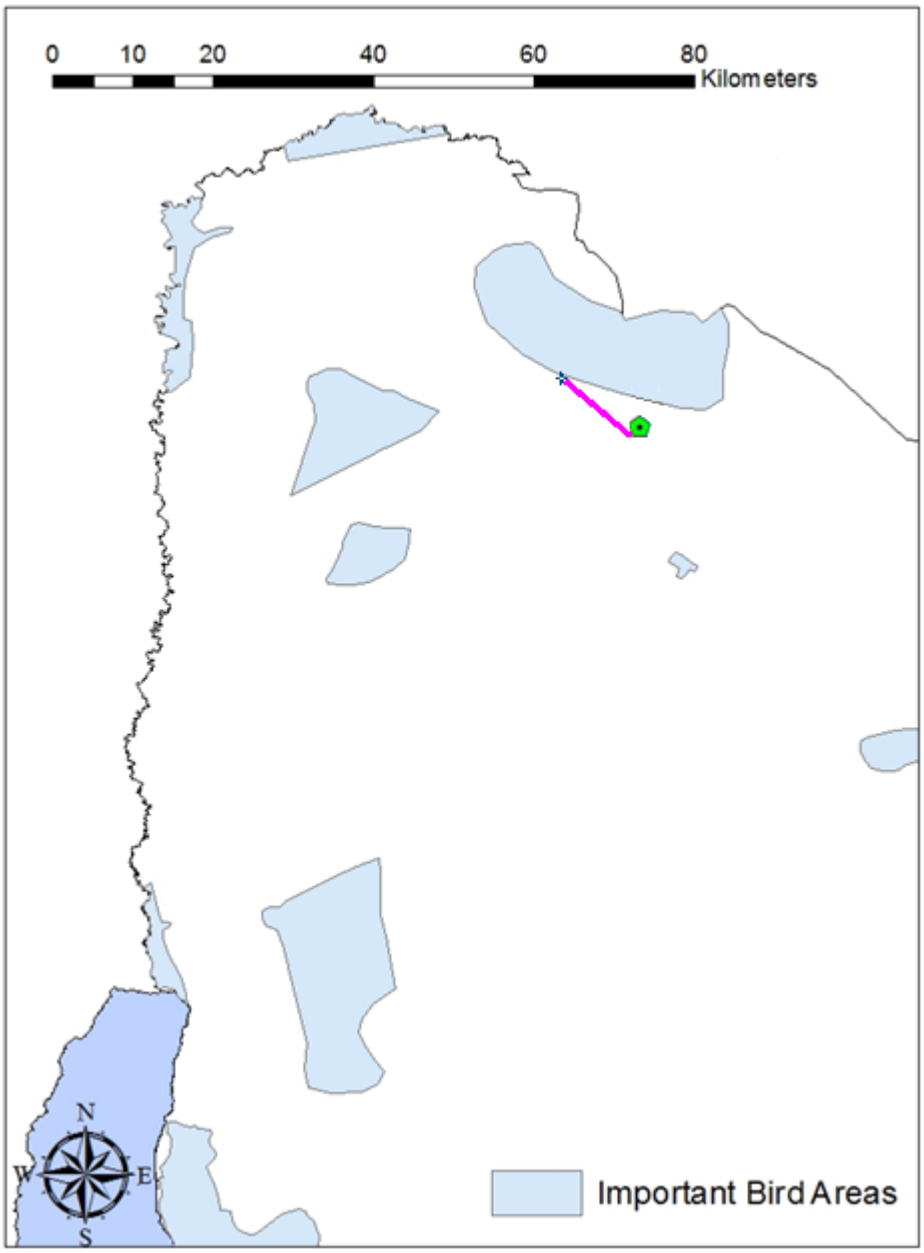
as heavy grazing activities were noticed, and urbanization has increased which highlighted the urgent need to reconsider updating the IBAs book in Jordan to accommodate changes that has happened until 2014". This is already agreed upon between Jordanian Ornithologists, furthermore, an attempt was performed by the bird life international to review the existing IBAs in the Middle East countries including Jordan, but this was stopped due to the political situation in the area".

IFC and Al Shamil engineering contacted RSCN for reconsidering Irbid- Mafraq IBA due to the above mentioned facts, taking into consideration that the transmission line will pass through the ROW of Mafraq-Irbid national road and the ROW of the planned and approved streets.

Figure 5.2.11 shows the location map of the Mafraq IBA, the proposed PV plant site, the proposed transmission line and Al Hasan substation.



Figures 5.2.9: Project locations in relation to Important Bird Areas



Figures 5.2.10: Closer image to the Project locations in relation to Important Bird Areas

Figure 5.2.11: The location map of the Mafraq IBA, the proposed PV plant site, the proposed transmission line and Al Hasan substation

5.2.6 Methods

The study has been accomplished in two stages; stage one related to the PV plant and accomplished in June 2014, and stage two related to the selected route of the transmission line accomplished in September 2014. Maps generated from Google earth and processed by Geographical Information System (GIS) software type ESRI ArcView 9.3. All locations were recorded using GPS UTM software downloadable from Apple Store with an accuracy of +/- five meters. The following methods were used during the survey.

5.2.6.1 Desktop Survey

This method entails obtaining all available information about biodiversity within the Irano-Turanian Bio-geographical zones since the project will be established within. Materials reviewed include historical and present information gained from the available published books, articles, reports of either published or un-published, and internet sources.

5.2.6.2 Field Survey

The Field survey included the following methods

Route Method

This method aimed to record faunal and floral species present at the PV plant site where a total of three route transects were conducted each with a total length of 700 meters. Start point was selected based on the presence of wadis and\or randomly and the team walked for unspecified time depending mainly on the topography and to cover the distance defined previously. While walking, all records of floral species and/or faunal species were documented and any signs of live specimens, animal droppings, skulls, footprints were recorded.

In addition the biodiversity study team walked along the selected route of the transmission line which passes in the ROW of Mafraq-Irbid national road no. 10 and other planned and approved streets.

Opportunistic Observation

Any causal observations rather than the sighting within the systematic methods were recorded. This includes sightings of reptiles, mammals, birds and even plant species

5.2.8 Results

5.2.7.1 Flora Survey Results

Results of floral survey showed that a total of 16 floral species belong to 6 families are distributed in the project area. All species recorded are common to Jordan and widely distributed except the threatened Iris species which was found in good numbers at the study area (Table 5.2.1 and Figure 5.2.11). It's worth mentioning that in the time of the survey, it was difficult to identify the *Iris* sp. Since no flowering parts were present but only leaves!. However, all Iris species are threatened on the local level of Jordan based on Al Eisawi, 1996 publications and also if identified in the appropriate season, then we can understand if this is a red listed species based on IUCN, though most iris species are!.
It was found that the area is highly degraded and human effects were noticed all over the study area including agricultural practices and heavy grazing.

Table 5.2.1: Flora species recorded in the project location

Number	Family	Species	Common name	Status
1	Chenopodiaceae	*Anabasis articulata*	Anabasis	Common
2	Chenopodiaceae	*Noaea mucronata*	Noaea	Common
3	Compositae	*Aaronsohina factorovski*	Aaronsohina	Common
4	Compositae	*Asteriscus pygmaeus*		Common
5	Compositae	*Centaurea arabica*	Centaurea	Common
6	Compositae	*Ifloga spicata*	Iflago	Common
7	Compositae	*Onopordon ambigum*	Cotton Thistle	Common
8	Compositae	*Echinops polyceras*	Globe-thistle	Common
9	Compositae	*Filago sp.*	Filago	Common
10	Geraniaceae	*Erodium sp*		Common
11	Gramineae	*Hordum marainum*	Barely	Common
12	Gramineae	*Bromus sp.*	Bromus	Common
13	Gramineae	*Cynodon dactylon*	Couch Grass	Common
14	Liliaceae	*Asphodelus aesitvaus*	Asphodelus	Common
15	Iridaceae	*Iris spp.*	Iris	Threatened
16	Caryophyylaceae	*Paronychia sp.*		Common

Figure 5.2.12: fauna species recorded in the site

Figure 5.2.13: Iris sp. found in the study site

Figure 5.2.14: floral species found in the study site

5.2.7.2 Fauna survey results

The following results are for the Fauna survey.

Mammals

Three species of mammals were recorded including *Vulpes Vulpes, Canis familaris* and *Dipodillus dasyurus*. Table (5.2.2) shows the mammal species with the common name and status.

Table 5.2.2: Fauna species recorded in the project location

Number	Group	Species name	Common name	Status
1	Mammals	*Vulpes Vulpes*	Red Fox	Common
2	Mammals	*Canis familaris*	Feral Dog	Common
3	Mammals	*Dipodillus dasyurus*	Wagner's Dipodil	Common

Reptiles

Three species of reptiles were observed in the project area including the Snake- eyed Lizard; *Ophisops elegans*, the Syrian Agama; *Trapelus ruderatus*, and Fan footed Gecko; *Ptyodactylus guttattus*, Table (5.2.3) shows the reptiles common name and status in the project area.

Table 5.2.3: the reptiles, common name and status in the project area

Number	Group	Species name	Common name	Status
1	Reptiles	*Ophisops elegans*	Snake- eyed Lizard	Common
2	Reptiles	*Trapelus ruderatus*	Syrian Agama	Common
3	Reptiles	*Ptyodactylus guttattus*	Fan footed Gecko	Common

Amphibians

A single species of amphibians was recorded in the project site which is the Green Toad *Buffo viridis*.

Table 5.2.4: the common amphibian found in the area

Number	Group	Species name	Common name	Status
1	Amphibians	*Buffo viridis*	Green Toad	Common

Avifaunal Species Diversity

The monotonic poor habitat coverage and deterioration of this area leaves little chance for wild birds to inhabit or depend on this type of habitat for feeding. Field investigation proofed that the area of least significant to bird populations.

Scarcely scrubby and bushy areas exist outside populated areas; these spots are often productive for migrant warblers and shrikes. Migrating raptors and storks can also pass over the area in low numbers. However, table (5.2.5) shows the common species in the project site and table (5.2.6) presents the avifaunal species during the migration season (spring, autumn).

Table 5.2.5: the common species in the project site

Number	Group	Species name	Common name	Status
1	Birds	Passer domesticus	House Sparrow	Common
2	Birds	Galerida cristata	Crested Lark	Common
3	Birds	Streptopelia turtur	Turtle Dove	Common
4	Birds	Pycnonotus goiavier	Yellow-vented Bulbul	Common
5	Birds	Upupa epops	Hoopoe	Common

Table 5.2.6: The avifaunal species during the migration season (spring, autumn)

Family	Scientific name	Status
Ardeidae	Ardea purpurea	Migrant
Ciconiidae	Ciconia ciconia	Migrant
Falconidae	Falco tinnunculus	Resident
Columbidae	Streptopelia decacoto	Resident
	Streptopelia senegalensis	Resident
Alaudidae	Ammomanes deserti	Resident
	Galerida cristata	Resident

5.3 Socio-Economic Environment

Socio-economic indicators are collected to have baseline data for socio-economic conditions of Mafraq Governorate and Husha sub district where the PV plant is located as the PV is the major component of the project and covers an area of about 1400 dunum. While the transmission line will pass over the ROW of the Mafraq-Irbid national road and other streets for a distance of 13 km, which means that the poles of the transmission line will occupy a total area of 1 dunum of Buwaida area/ Ramtha.

Such data is collected from the involved regulatory such as Department of Statistics, Ministry of Planning, Ministry of Tourisms and Antiquities, and others. These indicators include the population, economic constituents, labor forces, health indicators, archeological heritage and infrastructure of the project area. In order to propose a mitigation plan and instructions to eliminate or reduce the project impacts on the archeological sites, an archeological survey at the project area and surrounding was conducted as the archaeological heritage is of a significant environmental component in such area.

Mafraq governorate is located in the north-eastern part of Jordan; it is the only governorate in Jordan that has borders with three countries: Iraq to the east, Syria to the north, and Saudi Arabia to the south. Mafraq governorate covers the second largest area in the kingdom, but yet the second smallest population density (after Ma'an).

Mafraq governorate includes in addition to Mafraq Qasabah District (the city) three other districts, namely; Badiya Shamaliyah (North Badiya), Badiya Shamaliah El Gharbiah (North West Badiya), and Rwaished. The four districts are further divided into 14 sub-districts served by 18 municipalities.

Husha area, where the PV plant is located is within Badiya Shamaliah El Gharbiah (North West Badiya) and within the mandate of greater Husha municipality; which comprises Husha and Al Hamra. The PV plant project site is under the jurisdiction of Husha and Hamra municipalities.
Following is a discussion for some socio-economic indicators of Mafraq area.

5.3.1 Population Characteristics

Mafraq is Jordan second largest governorate in terms of area with 29.9% of the total area of the kingdom, but with a small population compared to other governorates with 4.7% of Jordan total population with a total of 300,300 citizens of which females constitute 48.2% of Mafraq total population (DOS, 2012). It's worth mentioning that Mafraq governorate is highly affected by the fluxes of Syrian refugees, as it received a total number of about (618,610 refugees) during the last three years. These numbers of refugees impose loads on the resources in Mafraq governorate, including water, electricity, and food and even share mafraq people on job opportunities on the manpower. These fluxes of refugees affect the

health care services in Mafraq governorate as it makes the health care centers loaded with high numbers of patients.

The age structure of Mafraq population shows that it is a young community having 39.9% of the community below the age of 15 years, and 69.2% of the community is below the age of 30 years. Only 3.6% is above age 65.

Social Matrix and Population Density

Mafraq governorate is characterized by three major social environments; these are the city style, the village style, and nomadic. The city style is represented by Mafraq city. In spite of that, the 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 Mafraq area. Nomadic population is decreasing due to several factors, however nomads move on seasonal basis in search of proper range land to feed their livestock. The patterns of movement require further studies. Livestock production is considered a major sector in Mafraq and contributes to the dominance of the village life style.

Urbanization in Jordan has been growing very fast mainly in the last 30 years. About 78.7 percent are living in urban centers and the total density rate is 61.7 persons/ km^2. The total area of Mafraq is 26435 sq.km and population density in Mafrqa is considered of the lowest in the kingdom with 9.3 or less persons/ km^2.

Urban population in Mafraq forms around 54.88% of the total population, and thus having 45.12% of the population as rural communities.

Tables (5.3.1-5.3.4) show the statistics related to population in Mafraq governorate

Table 5.3.1: Estimated Population of Mafraq by the sex at the end of 2012

Male	Female	Total	%
155600	144700	300300	4.7

Table 5.3.2: Estimated Population of Mafraq by the Urban and Rural at the end of 2012

Urban	Rural	Total
2325500	182500	300300

Table 5.3.3: Estimated Population of Mafraq by the Administrative Division at the end of 2012

Administrative Division	Population
Mafraq Qasabah District	**125080**
Mafraq Sub District	70050
Ba'lama Sub District	25570
Irhab Sub District	20370
Manshiyah Sub District	9090
Badiah Shamaliyah District	**70970**
Salhyia Sub District	20950
Sabha Sub District	12170
Um Al Jemal Sub District	17920
Dair Al Kahf Sub District	9150
Om El Qutain Sub District	10780
Badiyah Shamaliyah Gharbiyah District	**92190**
Badiyah Shamaliyah Gharbiyah Sub District	28880
Serhan Sub District	20110
Hosha Sub District	17430
Khaldiah Sub District	25770
Rwaished District	**12060**

Table 5.3.4: Estimated population of Mafraq by area and population density at the end of 2012

Population	Area		Population Density
	Km2	%	
300300	26551	29.90	11.3

5.3.2 Education

Jordan is a developing country with prime interest in the advancement of the education system to improve livelihood. Thus, illiteracy rate for Jordan population for the age range 15+ is in continuous decline, this rate is now around 4.1% for males and 11.4% for females with a gender gap of -7.3%.

As will, and since the age structure in Jordan illustrates characteristics of young population, illiteracy rates will continue to decline in response to the obligatory elementary education system and as will the laws forcing strict measure to combat illegal employment of children. The education system demonstrated significant improvement at all levels, including the growth in the number of educational organizations.

As for Mafraq, the improvement in the education system is also evident. The distribution of students by cycle and gender for the educational year 2012 and the distribution of schools in Mafraq for the same educational year are provided in tables (5.3.5- 5.3.8).

Table 5.3.5: Number of schools and class units by directorate and sex, 2012

Directorate	Schools				Units			
	Male	Female	Co-edu.	Total	Male	Female	Co-edu.	Total
Mafraq Qasabah	61	15	129	205	633	596	508	1736
Badyah Shamaliyah (East)	55	5	98	158	576	519	349	1444
Badyah Shamaliyah (West)	54	11	92	157	792	504	376	1372
Total	**170**	**31**	**319**	**520**	**1700**	**1619**	**1233**	**4552**

Table 5.3.6: Number of Students and teachers by directorate and sex, 2012

Directorate	Students			Teachers		
	Male	Female	Total	Male	Female	Total
Mafraq Qasabah	18224	17284	35508	1099	1692	2791
Badyah Shamaliyah (East)	12668	11125	23793	1067	1246	2313
Badyah Shamaliyah (West)	13610	13212	26822	857	1413	2270
Total	**44502**	**41621**	**86123**	**3023**	**4351**	**7374**

All over Jordan, the education level is very high, where 8 governmental universities in addition to 12 private universities are located. In Mafraq, there is one governmental university (Al Al-Bayet University) which was established in 1992.

The University is located on the outskirts of the city of Mafraq, 65 Kilometers to the north-east (about 45 minutes drive) of the capital Amman - Jordan. The university has integrated academic facilities, student housing, and social services on one site, extending over an area of 7539 dunums (dunum=1000 square meters). It constitutes seven faculties and five institutions. Table 5.3.7 show the number of Undergraduate students by sex, and post graduate students by degree at Al – Al bayit university In Mafraq, 2012 and No. of Academic staff at Al-Albayit University by education level, 2012.

Table 5.3.7: Number of under graduate students by sex, and post graduate students by degree at Al – Al Bayit University in Mafraq, 2012

Under graduate students			post graduate students			
Male	Female	Total	High Diploma	M.A./ M.Sc.	Ph.D.	Total
5591	7179	12770	155	675	0	830

Table 5.3.8: No. of academic staff at Al-Albayit University by education level, 2012

B.Sc.	H.Dip.	M.A./ M.Sc.	Ph.D.	Total	Female
0	0	46	271	317	50

The Relation with the University Community

Al Al-Bayet University is located few kilometers from Mafraq city centre on the main road to Jaber borders. Since its establishment in 1992, it contributed positively to reducing migration of highly educated professionals and young students who used to move to Amman, Irbid and Zarqa in search of university education. It also contributed to reducing unemployment in Mafraq, especially highly educated people who started to find good employment opportunities in the university.

5.3.4 Health

More than 80% of the population of Jordan is medically ensured. Medical insurance is sponsored by the following three different institutions:

- The Ministry of Health - Medical Insurance Corporation: This type of medical insurance covers almost all Government employees. It includes medical treatment, hospitalization, and medicine free of charge. Medical premiums paid by the ensured employee are 3% of gross salary.
- The Armed Forces: All military personnel and security forces including retired persons are also medically ensured for treatment, hospitalization and medicine.
- Establishments employing 5 persons and more must be subscribed in the Social Security Program at the Social Security Corporation. Normally, this type of insurance is applied to all risks including labour accidents. Charges paid by employees are in proportion to their gross salary, where 5.5% is paid by the employee and 10.5% paid by the establishment. For medical treatment in the private insurance companies, the actuarial principles are applied.

More than 1,415 medical centers and clinics of the Ministry of Health are spread all over towns and villages in the Kingdom. Comprehensive health centers and some of the primary health centers include maternal clinics, child clinics and dental clinics. All towns and villages in Mafraq area are provided with either a comprehensive or a primary health clinic.
Mafraq Governorate has 8.8% of the total comprehensive health care centers in Jordan, 6.7% of primary health centers, 9.2% of secondary health centre, 6.2% of maternal and child clinics, and 5.7% of dental clinics.
Tables (5.3.9-5.3.11) show the statistics of health indicators in Mafraq governorate.

Table 5.3.9: Employees at the ministry of health at Mafraq by position and directorate

Directorate	Physicians					Pharmacist	Nurse (F&M)	Midwife	Others
	Specialist	General	Resident	Dentist	Veterinary				
Mafraq	28	50	26	34	0	20	285	70	744
Badyah Shamaliyah	9	47	12	25	0	14	84	31	388

Table 5.3.10: Ministry of Health's centers, clinics and Pharmacies at Mafraq by Directorate, 2012

Directorate	Health centers	Village centers	MCH centers	TB centers	Dental centers	Pharmacies
Mafraq	32	23	30	1	26	49
Badyah Shamaliyah	18	13	15	0	14	-

Table 5.3.11: No. of Hospitals and beds at Mafraq by Health sector, 2012

Ministry of Health		Private Hospitals		Other Gov.		Total	
No. of Hospital	No. of Beds	No. of Hospital	No. of Beds	No. of Hospital	No. of Beds	No. of Hospital	No. of Beds
3	197	1	40	0	0	4	237

5.3.4 Economic Activity and unemployment

As in many parts of the kingdom, employment in the governmental sector is the major source of income for the majority of the residences within the project area. Workings in the services sector and in the agricultural sector are in the same level of importance as the second source of income for the locals. The total employees in the health care center in 2007 were 28,337 males and 25,000 females; more than 97.7% of this workforce is Jordanians.

The education and service sectors are flourishing sectors in Mafraq city with relation to students needs especially by the presence of governmental university. Also being the first city after crossing the Jordanian-Saudi borders creates significant demand on the service sector and on trade especially during Ramadan and Hajj Islamic seasons.

Working in the agriculture sector still an important source of income for many of the residences in Mafraq Governorate and especially in the villages scattered within the governorate and also to investors from elsewhere from Jordan.

Official governmental figures show that, the unemployment percentage in the kingdom is about 14.5%. This figure increased in the cities outside Amman and also increased between females more than males.

Unemployment is considered one of the most outstanding social and economical problems in Jordan, where the Jordan Department of Statistics estimated the Unemployment Rate at 14.5%. Unemployment among males reached 13.4% while unemployment among females is estimated at 20.8%.

The percentage distribution of monthly income in Jordanian Dinar by the resident families in Mafraq is in most below JOD 300.0 with about 68.7% compared to 55.5% in Amman and 75.8% in Ma'an.

Tables (5.3.12-5.3.11) show the statistics of economic activities and unemployment indicators in Mafraq governorate.

Table 5.3.12: Comparison between the economic indicators in Mafraq Governorate and in the kingdom

Indicator	Mafraq	Kingdome
Number of employed persons	55665	1268093
Percentage of employed persons	%4.4	
Number of unemployed persons	6650	175470
Percentage of unemployed persons	3.8	
Number of foreign employed persons	12394	279798
Percentage of foreign employed persons	%4.4	
Average Gross economic activity	22.5	25.1
Average refined economic activity	36.4	38
Average of Unemployment	10.7	12.2
Inflation rate	5.45	4.77
Average annual family income (JOD)	7276.3	8823.9
Average annual family expenses (JOD)	7674.7	9626
Average annual individual income (JOD)	1228.7	1660.2
Average annual individual expenses (JOD)	1290.3	1793.0
Poverty average (2010)	19.2	14.4
Percentage of families with middle life style	14.1	41.0
Number of establishments under the umbrella of social security	703	27905

Table 5.3.13: Economic activity, number of establishments and number of workers in Mafraq

Economic Activity	Number of establishments	Number of workers
Extraction Industries	37	404
Food and agricultural industries and livestock	33	632
Leather industries	83	246
Chemical industries and cosmetics	7	246
Medical industries and medical	8	80
Construction industries	27	155
Plastic and rubber industries	4	72
metal industries	266	1182
Engineering, electronic and information technology industry	18	258
Wood and furniture industries	4	19
Total	**487**	**3294**

As the transmission line passes through Husha area of Mafraq governorate and Buwaida area of Ramtha district/ Irbid Governorate, some socio-economic indicators of Ramtha district will be presented in this section of the study.

Table 5.3.14: Estimated population of ramtha district at the end of 2012

Administrative division	Population
Ramtha District	133690

5.3.15: Number of Schools and Class Units of Ramtha District by Sex, 2011/2012

Schools				Class Units			
Male	Female	Co-edu	Total	Male	Female	Co-edu	total
27	16	**77**	120	440	474	**410**	1324

5.3.16: Number of Students and Teachers of Ramtha District by Sex, 2011/2012

Students			Teachers		
Male	Female	Total	Male	Female	Total
19032	18402	37434	799	1399	2198

5.3.17: Number of Under - Graduate Students at Science & Technology University by Sex, 2011/2012

Male	Female	Total
10068	11384	21452

5.3.18: Number of Academic Staff at Science & Technology University by Educational Level, 2011/2012

B.Sc.	H.Dip.	M.A.	Ph.D	Total	Female
0	0	143	671	814	191

5.3.19: Employees at the Ministry of Health of Ramtha District by Profession, 2012

Physicians					Pharmacist	Nurse (M&F)	Midwife	Other
Specialist	General	Resident	Dentist	Veterinary				
30	23	13	10	0	5	148	44	334

5.3.20: Ministry of Health's Centers and Clinics by Directorate at of Ramtha District, 2012

Health Centers	Village Centers	MCH Centers	T.B. Centers	Dental Clinics
12	0	11	0	9

5.4 Archaeological and Cultural Heritage

An independent archaeological study for the project area and the surrounding was conducted by Al Shamil Engineering archaeological team upon the request of JSO to have details on this valued environmental component.

This section of the EIA study covers the main results of the above mentioned study, which are considered the baseline of the archaeological and cultural heritage. The study team conducted a study that covers the archeological sites and cultural heritage in the proposed project site, particularly the PV plant site, as it covers an area of about 1400 dunum. While the transmission line will have disturbed area not exceeding 1 dunum all along its distance, which means there is no expected archaeological site in these areas, taking into consideration that the line passes through already disturbed areas.

The protection of archaeological heritage must be based upon effective collaboration between professionals from many disciplines. It also requires the co-operation of Government and the General Public. The archaeological heritage whether located in the project site or the surrounding constitutes the basic record of past human activities. Its protection and proper management is therefore essential to enable archaeologists and other scholars to study and interpret it for the benefit of present and future generation.

5.4.1 Objectives

This part of the study is aimed to serve as the basis for the impact assessment of the project-related activities on archeological and cultural heritage resources, and as a framework of the requirements to be reviewed by the related parties who are involved in the project. The major issues of concerns related to the archaeological and heritage are:

- Potential damage to archaeological or heritage sites while landscaping and sites preparation activities.
- The discovery of any archaeological remains during site preparation activities.

In order to establish the archaeological baseline data for the EIA study, an archaeological survey was carried out by the archeological team. The methodology adopted for this study is based on literature review, field investigation and documentation.

5.4.1.1 Literature review

Most of the available Literature review that is related to the study in addition to database was reviewed such as:

- Jordan Antiquities Database and Information System (JADIS).
- Department of Antiquities of Jordan (DAJ).

5.4.1.2 Field work investigation

The study team investigated the project area and the surrounding zone, so the whole area of the proposed PV plant is visited. The survey was conducted by walkover, where the archaeologist walked in strips that covered the project site.

5.4.1.3 Conclusion

According to the literature and field investigation, it's found that Mafraq governorate including Mafraq city and the surrounding contains a number of locally important cultural and religious sites, most significant of which are the remains of a castle that dates to the Second Iron Age. Another castle called the Fadin Castle was added during the Umayyad period to the original castle. Another significant site is Umm Al-Jimal known as the Black Oasis because of the black basalt rock from which many of its houses, churches, barracks and forts were built. The most significant site is the Desert castles of Umm Al-Jimal.

During the site investigation, the archaeologist didn't record any antiquities in the proposed PV plant site, and a clearance[4] from Al-Mafraq Department of Antiquities was obtained before starting the pre-construction and construction phase of the project. Moreover, upon discovery of any archaeologically significant ruins on site, construction should stop and the authorities should be informed to undertake the proper measures.

[4] A copy of the letter of clearance is shown in annex (6)

6. Public Involvement and Consultation

The aim of the public participation process is primarily to ensure that:

- Information containing all relevant facts in respect of the proposed project is made available to potential stakeholders and I&APs;
- Participation by potential I&APs should be facilitated in such a manner that all potential stakeholders and I&APs should be provided with a reasonable opportunity to comment on the proposed project;
- Comment received from stakeholders and I&APs should be recorded and incorporated into the EIA process;

For the purpose of this study, the consultation is to be undertaken through public scoping session, community consultation and focus group meetings.

6.1 Community consultation

In order to accommodate the varying needs of stakeholders, particularly the local community of Husha and surrounding villages interested and affected people (I&APs), a consultation was conducted through interviews with selected people from the different sectors in Husha community considering the gender issue.

Local community consultation was already undertaken through a program arranged in cooperation with the mayor of greater Husha, which comprises many areas surrounding Husha, such as Al Hamra, Mshirfeh, and Ekeder. In addition, the director of Husha municipality area was involved in the consultation process.

Selected people were consulted representing educational, social, and agricultural sectors, in addition to journalist and citizens of Husha.

The community consultation was conducted within 2 days (25-26 June, 2014). Al Shamil Engineering team prepared and distributed a questionnaire for the selected people with a brief on the project description and objectives. The questionnaire was collected and analyzed. The followings were concluded from the answers to the questionnaire.

- Most of the consulted people encourage the establishment of the PV plant;
- The consulted people expected the project will create job opportunities for Husha community;
- Most of the consulted people see that the project will not affect the residential area as the project is out of the village planning areas;
- The consulted people see that the project will not have impacts on agricultural and livestock in the area;

- The consulted people sees that the project will contribute to the implementation of the Jordanian renewable energy strategy;
- Most of the consulted people trust that the project will encourage other investment in the project area;
- The local community appreciates the assistance of the project in human resources development in Husha area;

However, the questionnaire and the list of consulted people names, job title, and contact information are attached as an annex (4).

6.2 Public Scoping session[5]

According to the national regulations, a scoping session shall be organized by the ministry of environment and the participation of other regulating authorities, which have jurisdiction to the proposed project, in addition to the people from the local community and NGOs and other interested individuals.

A public scoping session was held in Aug. 28th, 2014 at CORP hotel/ Amman. This scoping session was organized in full coordination between Al Shamil Engineering, the Ministry of Environment and the client (Jordan Solar One (JSO)).

The purpose of this scoping session is to engage all parties involved in the project. The stakeholders are governmental and nongovernmental organizations including the local communities of the project areas.

The disclosure for the proposed project was the main part of the presentation in which the project components were described. The objective of this session is to collect the stakeholders' views and concerns on the two components of the project in order to be considered in the analysis, identification, and assessment of the project impacts.

[5] Scoping session report is attached as annex (3)

6.3 Focus Group meetings

To engage the interested and affected people in the two components of the proposed project (PV and TL) from Husha and Buwaida areas where the two project components are located, focus group meetings were undertaken for Husha and Buwaida communities. The first focus group meeting was for Husha area and was held in Husha municipality in 9.6th,2014. The attendees[6] of this meeting represent the different categories of the community and include the mayor of greater Husha, husha municipality directors, greater husha municipality council members, citizens. In parallel to this meeting, a separate meeting with some of the women of Husha community was conducted; those women represent housewives, social workers and municipality council member.

The second focus group meeting was held in Buwaida area at the municipality hall in 9.10th,2014. The attendees of this meeting also represent the different categories of the community and include the Buwaida municipality council, Buwaida municipality director, teachers, citezens and a local contractor.

During these meetings, Al Shamil Engineering presented a non technical summary of the project including project components, purpose, objectives, extent, land borders, impacts emphasizing on the social impacts on Husha and Buwaida areas and grievance mechanism.

Positive responses towards the proposed project were noticed in the two meetings. The main concerns of the two communities were the employment opportunities given to the local sitizens of the two communities, and how such project will be reflected on the cost of electricity bills.

[6] Annex (5) the names of the attendees

7. Anticipated Potential Impacts and Assessment

This chapter serves to assess the significance of the positive and negative environmental impacts (direct, indirect) expected to be associated with the development of the proposed project components through the different phases of the project implementation.

- **Pre-construction and construction phase**; this phase will include pre-construction surveys; site preparation; establishment of the access road, electricity generation infrastructure, lay down areas, transportation of components/construction equipment to the project site. This phase is expected to take approximately 18 months for the two project's components.

- **Operation phase**; this phase will include operation of the PV plant, the generation of electricity and dispatching the generated electricity to the Al Hasan electric substation (132/33kv) through the proposed transmission line. The operational phase is expected to extend in excess of 20 years.

- **Decommissioning phase**; depending on the economic viability of the plant, the length of the operational phase may be extended. Alternatively decommissioning will include site preparation; disassembling of the components of the two components of the project; clearance of the site and rehabilitation. For the purpose of this study, as the impacts associated with decommissioning are expected to be similar to construction. Therefore, these impacts are not considered separately.

The outcomes of the above described activities could be divided into environmental aspects and environmental impacts. The aspects are defined as any element of an organization's activities, products or services that can interact with the environment. And the environmental impact could be defined as any change to the environment, whether adverse of beneficial, wholly or partially resulting from an organisation's activities, products or services.

The aspects which are generated from the above activities may lead to one or more impacts while many aspects may share the same impact.

7.1 Assessment of Issues

The study team considered direct, indirect, and residual environmental impacts associated with the development of the proposed project components (PV and TL) in Husha and Buwaida areas. Issues were assessed in terms of the following criteria:

1. The **nature**, a description of what causes the effect, what will be affected, and how it will be affected;
2. The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development), regional or national. A score of between 1 and 5 is assigned as appropriate (with a score of 1 being low and a score of 5 being high);
3. The **duration**, wherein it is indicated whether:
   - The lifetime of the impact will be of a very short duration (0–1 years) assigned a score of 1
   - The lifetime of the impact will be of a short duration (2-5 years) – assigned a score of 2
   - Medium-term (5–15 years) – assigned a score of 3
   - Long term (> 15 years) - assigned a score of 4
   - Permanent - assigned a score of 5
4. The **magnitude**, quantified on a scale from 0-10, where a score is assigned:
   - 0 is small and will have no effect on the environment
   - 2 is minor and will not result in an impact on processes
   - 4 is low and will cause a slight impact on processes
   - is moderate and will result in processes continuing but in a modified way
   - is high (processes are altered to the extent that they temporarily cease)
   - is very high and results in complete destruction of patterns and permanent cessation of processes
5. The **probability of occurrence**, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale, and a score assigned:
   - a score of 1–5, where 1 is very improbable (probably will not happen)
   - a score of 2 is improbable (some possibility, but low likelihood)
   - a score of 3 is probable (distinct possibility)
   - a score of 4 is highly probable (most likely)
   - a score of 5 is definite (impact will occur regardless of any prevention measures)

6. The **significance**, which is determined through a synthesis of the characteristics described above (formula below) and can be assessed as low, medium or high

S = (E+D+M) P; where

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- **< 30 points:** Low (i.e. where this impact would not have a direct influence on the decision to develop in the area)
- **30-60 points:** Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated)
- **> 60 points:** High (i.e. where the impact must have an influence on the decision process to develop in the area)

- The **status**, which is described as either positive, negative or neutral;
- The degree to which the impact can be reversed;
- The degree to which the impact can be mitigated

As the developer has the responsibility to avoid or minimize impacts and plan for their management, the mitigation of significant impacts is discussed. Assessment of impacts with mitigation is made in order to demonstrate the effectiveness of the proposed mitigation measures. EMP for the project is prepared in a separate report.

7.2 Assessment of the Potential Impacts associated with the Construction and Operation Phases

A summary of the findings of the assessment undertaken for potential impacts associated with the construction and operation of the two components of the proposed project on project area will be provided in the next sections. Issues were assessed in terms of the criteria detailed above. The nature of the potential impact is discussed; and the significance is calculated with and without the implementation of mitigation measures. Recommendations are made regarding mitigation/enhancement and management measures for potentially significant impacts and the possibility of residual impacts are noted.

7.2.1 Potential Impacts on biodiversity

The proposed PV plant component of the project requires a large area of land for placement of infrastructure. The proposed project requires 1400 dunum; the most important expected negative impacts of this project will be due to loss of habitats which may have direct or indirect impacts on the individual species. Potential impacts on the biodiversity are summarized below.

The majority of impacts on biodiversity will occur during the construction of the proposed PV plant component of the project.

As mentioned before, the construction of the transmission line will disturb a land of about 1 dunum, which means that the construction of the transmission line will have minimal impacts on the biodiversity.

Potential impacts on biodiversity resulting from the development would stem from different activities and risk factors related to the pre-construction, construction and operational phases of the project including the followings.

For the pre-construction and construction phase,

- Land clearance
- Gas and dust emissions
- Noise generation
- Equipment and vehicle movement
- Change of land use

For the operational phase,

- Creation of electromagnetic field (EMF)
- Physical presence of poles and conductors
- Accidents from electrocutions

The above activities and risk factors may cause the following impacts.

- Impacts on vegetation;
- Increased alien plants invasion risk;
- Soil erosion risk;
- Faunal impacts;
- Avifauna impacts; and
- Fragmentation of landscape.

Tables summarizing the significance of impacts on biodiversity (with and without mitigation)

Nature: Impacts on vegetation Impacts on vegetation would occur due to the construction of the PV plant and the transmission line which will require extensive site clearing. Some loss of vegetation is an inevitable consequence of the development.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (3)
Magnitude	Medium (6)	Medium (4)
Probability	Highly probable (4)	Highly probable (4)
Significance	**Medium (44)**	**Medium (32)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Can impacts be mitigated?	Largely Not, as all the woody vegetation present will need to be cleared.	
Residual Impacts: The development requires that all the woody vegetation within the development footprint is cleared, which cannot be avoided or fully mitigated.		

Nature: Increased alien plant invasion Alien plants are likely to invade the site as a result of disturbance created during construction phase of the project components**.** Disturbance created at the working site during construction would leave the site vulnerable to alien plant invasion. Clearing the site would result in a large amount of disturbance and as the grass layer is poorly developed, it is not likely that an indigenous plant cover would rapidly colonize the cleared areas to limit the invasion potential of the area.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (2)
Magnitude	minor (2)	No effect (0)
Probability	Improbable (2)	Very Improbable (1)
Significance	**Low (14)**	**Low (3)**
Status (positive or negative)	Negative	Neutral
Reversibility	Low	High
Can impacts be mitigated?	Yes	
Residual impacts: If alien species at the site are controlled, then there will be very little residual impact		

Nature: Increased erosion risk as a result of soil disturbance and loss of vegetation cover The development of the site would create soil disturbance, which would leave the site susceptible to erosion. It's worth mentioning that the rainfall in the project site is low to make the site susceptible to erosion as the maximum rainfall for 24 hours estimated for a long period doesn't exceed 50 mm. although, the panels and hardened surfaces of the roads and other infrastructure would increase the runoff.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (2)
Magnitude	Minor-low (3)	Small -minor (1)
Probability	Probable (3)	improbable (2)
Significance	**Low (24)**	**Low (8)**
Status (positive or negative)	Negative	Neutral
Reversibility	Low	High
Can impacts be mitigated?	Yes	
Residual Impacts: If erosion at the site is controlled, then there will be no residual impact		

Nature: Disturbance, transformation and loss of habitat will have a negative effect on resident fauna. During the construction phase, there will be a lot of disturbance and noise at the site which will drive many species away from the area. The presence of construction personnel will also lead to increased risk to species such as snakes, tortoises and mammals. During the operational phase, the large change in vegetation structure will render the area unsuitable for many species which will consequently experience long-term habitat loss as a result.		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Medium (5)	Low (3)
Probability	Definite (5)	Highly Probable (4)
Significance	**Medium (55)**	**Medium (36)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	
Can impacts be mitigated?	Some aspects such as those relating to human activity can be mitigated, but habitat loss cannot be mitigated.	
Residual Impacts Some habitat loss is an inevitable consequence of the development and cannot be fully mitigated.		

Nature: Birds Impacts birds will experience some habitat loss as a result of the development as well as a potentially increased risk of collisions and electrocution with the structure of the PV plant and the transmission line infrastructure.		
	Without mitigation	**With mitigation**
Extent	regional (3)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Medium (6)	Minor - Low (3)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (52)**	**Low (27)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Can impacts be mitigated?	To some degree	
Residual Impacts: The large change in vegetation structure resulting from the development would amount to long-term habitat loss for most species		

Nature: fragmentation of landscape The development would result in a large change in vegetation structure within the site, which would render it unsuitable for many species, while others would be excluded by the security fencing around the plant. This would make it difficult for affected fauna to move through the area.		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Medium (5)	Medium(4)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (44)**	**Medium (30)**
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	Moderate
Can impacts be mitigated?	No. The impact will remain in place for as long as the plant is present.	
Residual Impacts: The change in vegetation structure will be permanent and for those species which require such habitat, mitigation will not be possible. If a ground layer of grass and shrubs can be maintained within parts of the plant, many smaller species will benefit and the residual impact on such species will be low.		

7.2.2 Potential Impacts on soils and agricultural potential

The activities of the proposed project components (PV and TL) may have potential negative direct impacts in terms of soil loosening, erosion, compaction, and contamination in addition to the agricultural potential.

The activities may also cause indirect impacts such as dust emission generated from the site. However, we could say that the project implementation phases may have potential impacts which are likely to be insignificant on the soil and agricultural potential.

It's worth mentioning that the livestock of the PV plant neighboring communities that used to graze in the project site for a very short period during spring time will have minor loss of grazing land while the proposed project is being developed.

Moreover, the project will help mitigate the overgrazing and urbanization issue within the site of PV plant. The project site will be off limit to grazing animals and any building activities or housing developments will be restricted since this site is reserved for the purpose of the project usage for the next 20 years and possibly for another 20 years, as a second term. Total will be 50 years from the time this project is constructed. The PV plant components are all made of inert material which won't introduce any harmful materials into the surrounding environment and in fact may provide safe and secure environment for wild

birds on their way to the more desirable areas with water and vegetation about 20-50 KM away from the project site.

Impact tables summarizing the significance of impacts on soils (with and without mitigation)

Nature: Soil degradation (soil removal, mixing, compaction, etc.) due to the construction of foundations for structures (PV panels, buildings, TL poles and foundations and the access roads)		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	long term (4)	long term (4)
Magnitude	low (4)	Minor (2)
Probability	Definite (5)	probable (3)
Significance	**Medium (45)**	**Low (21)**
Status	Negative	Negative
Reversibility	Partially reversible	reversible
Can impacts be mitigated?	Yes	
Residual impacts: Minor loss of soil under structures.		

Nature: Soil degradation due to pollution of soil by contaminants used on site during construction (e.g. fuel, oil, chemicals, cement).		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium term (3)	Very short term (1)
Magnitude	Minor (2)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	**Low (18)**	**Low (12)**
Status	Negative	Negative
Reversibility	Partially reversible	Partially reversible
Can impacts be mitigated?	Yes	
Residual impacts: Minor loss of soil potential		

Nature: Impact on existing land-use.	
	Without mitigation
Extent	Local (1)
Duration	Long term (4)
Magnitude	Minor (2)
Probability	Improbable (3)
Significance	Low (21)
Status	Negative
Reversibility	Reversible
Can impacts be mitigated?	No
Residual impacts: Insignificant temporary loss of grazing land while The PV plant component of the project is in use.	

Nature: Reduction in agricultural potential		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Minor (2)	Low -Minor (1)
Probability	Probable (4)	Improbable (3)
Significance	**Low (28)**	**Low (18)**
Status	Negative	Negative
Reversibility	Reversible	Reversible
Can impacts be mitigated?	No	
Residual impacts: Minor loss of grazing land while The PV plant component of the project is in use.		

Nature: Increased dust pollution from construction sites affecting surroundings.		
	Without mitigation	**With mitigation**
Extent	Regional (2)	Local (1)
Duration	short term (2)	short term (2)
Magnitude	Low (4)	Minor (2)
Probability	Highly probable (4)	probable (3)
Significance	**Medium (32)**	**Low (15)**
Status	Negative	Negative
Reversibility	Irreversible	Irreversible
Can impacts be mitigated?	Yes	
Residual impacts: Minor localized dust pollution		

7.2.3 Potential impacts on archaeological sites

As the proposed project (PV and TL) area is void of archaeological sites as mentioned earlier in the baseline study of this report. No impacts from the activities of the project development phases are expected.

Impact tables summarizing the significance of impacts on heritage sites, or objects (with and without mitigation)

Nature: No sites falling within the Built Environment were identified during the Archaeological survey		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Short term (1)	Long term (1)
Magnitude	minor (0)	minor (0)
Probability	Very Improbable (1)	Very Improbable (1)
Significance	**Low (2)**	**Low (2)**
Status	Positive	Positive
Reversibility	Reversible	Reversible
Can impacts be mitigated?	Yes	Yes
Residual impacts: None		

7.2.4 Potential visual impacts

The topography of the proposed PV plant site indicates that the project site is flat with very low slope and located at a mean elevation of 729 m.a.s.l.

The distance between the observer and the observed activity (project development) is an important determinant of the magnitude of the visual impact, this is due to the visual impacts of any activity dimensioning between the viewer and the activity increases.

The viewsheds are categorized into three broad categories of significance, namely, foreground, middle ground and background. The sensitive receptors in the foreground and middle ground of the generated view shed represent Mafraq main road and Husha road.
The proposed project will present a change in land use and land form to the current status of the project site. The introduction of the foreign structures and forms may have a potentially significant impact on sensitive receptors.

The project site has a very low incidence of light sources, a slight sky glow effect is however visible at night. Direct open light sources are also visible at night. The PV string of the proposed project activity will not include lights of any kind, however, the associated ancillary buildings and infrastructure may include some degree of lighting.

Photovoltaic solar panels are designed to absorb sunlight in order to convert it into electricity, a mono crystalline silicon cell absorbs 2/3 of the sunlight reaching the panel surfaces. This effectively means that only 1/3 of the sunlight reaching the surface of a solar panel has a chance to be reflected. In addition, the PV panels have a reflectivity of around 30%, while surface materials such as dry soil has a reflectivity of around 45%, and grass type vegetation at 25%. Moreover, PV panels are installed at a fixed angle of around 30 degree.

The landscape through which the proposed line passes is rather a flat plain and a part of Irbid-Mafraq plains. The landscape of the part of the line that will be in the ROW of Mafraq-Irbid national road is flat as well as the part that passes through the urban areas of Buwaida. However, it's concluded that no significant impact on these landscape character. The route of the transmission line generally follows the lower ground, so, the influence on the landscape character would be local and quiet limited.

Impact tables summarizing the significance of visual impacts of the PV facility (with and without mitigation)

Nature: Potential visual impact on the sensitive receptors in the foreground and the middle ground. The sensitive receptors in the foreground and middle ground of the generated viewshed represent the Mafraq main road and Husha road.		
	No mitigation	**Mitigation considered**
Extent	Local (2)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	Medium (6)	Minor (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (36)**	**Medium (30)**
Status	Negative	Negative
Reversibility	Recoverable (3)	Recoverable (3)
Can impacts be mitigated	Yes	
Residual impacts: It is very possible that the status quo could be regained after decommissioning of the plant. Providing that the site is completely rehabilitated. The visual impact will therefore also be removed.		

Nature: Potential visual impact of the construction period on visual receptors. Construction periods are often characterized by an increase in construction vehicles and personnel and their associated impacts such as dust clouds, noise, potential pollution, safety considerations, etc.		
	No mitigation	**Mitigation considered**
Extent	Regional (3)	Local (2)
Duration	short term (2)	short term (2)
Magnitude	Medium (6)	Medium (6)
Probability	Probable (3)	Improbable(2)
Significance	**Medium (33)**	**Low (20)**
Status	Negative	Negative
Reversibility	Recoverable (3)	Recoverable (3)
Can impacts be mitigated	Yes	
Residual impacts: None.		

Nature: Potential visual impact of reflection of the PV Panels on the sensitive receptors		
	No mitigation	**Mitigation considered**
Extent	Regional (3)	Regional (3)
Duration	Long term (4)	Long term (4)
Magnitude	Medium (6)	Medium (6)
Probability	Improbable (2)	Improbable (2)
Significance	**Low (26)**	**Low (26)**
Status	Neutral	Neutral
Reversibility	Recoverable (3)	Recoverable (3)
Can impacts be mitigated	Yes	
Residual impacts: The status quo could be regained after decommissioning of the plant, providing that the site is rehabilitated to its current state		

7.2.5 Assessment of Potential Social Impacts

Impacts associated with the construction phase of a project are usually of a short duration (18 months) temporary in nature, but could have long term effects on the surrounding environment. The operational life of the project is 20 years, after which the plant would possibly be upgraded to continue its lifespan if feasible, or decommissioned. The impacts usually associated with the operational phase are therefore perceived by affected parties to be more severe.

7.2.5.1 Social Impacts associated with the Construction Phase

The key social issues associated with the construction phase include:

Potential positive impacts

- Creation of employment and business opportunities and opportunity for skills development and on-site training

Potential negative impacts

- Impacts associated with the presence of construction workers on site;
- Increased risk of stock theft, poaching associated with presence of construction workers on the site;
- Threat to safety and security of farmers associated with the presence of construction workers on site;
- Impact of heavy vehicles, including damage to roads, safety, noise and dust;
- Potential loss of grazing land associated with construction-related activities.

Nature of Impact: Creation of employment and business opportunities during the construction phase based on the information provided by JSO, the construction phase for a 20MW PV plant and a 33kv transmission line of 13 km is expected to extend over a period of 18 months and create approximately 170 employment opportunities. Of this total 60% (102) will be available to low-skilled workers (construction laborers, security staff etc.), 15% (26) to semi-skilled workers (drivers, equipment operators etc.) and 25% (42) to skilled personnel (engineers, land surveyors, project managers etc.). The work associated with the construction phase will be undertaken by contractors and will include the establishment of the PV plant and transmission line and the associated components, including, access roads and services.

The majority of the low-skilled employment opportunities associated with the project is likely to benefit members from the local communities. The low education and skills levels in the area may however hamper potential opportunities for local communities. The majority of the skilled and semi-skilled opportunities are likely to be associated with the contactors appointed to construct the proposed project and the associated infrastructure. The majority of contractors also tend to use their own staff and this may limit the potential for direct employment opportunities for locals during the construction phase. In the absence of specific commitments by the developer to set local employment targets the potential benefits for local communities are likely to be limited.

The hospitality industry in Husha and Buwaida and surrounding areas are also likely to benefit from the provision of accommodation and meals for professionals engineers, quantity surveyors, project managers, product representatives etc.), and other (non-construction) personnel involved on the project.

	Without enhancement	**With enhancement**
Extent	Local – Regional (2)	Local – Regional (3)
Duration	Short Term (2)	Short Term (2)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Highly probable (4)
Significance	Low (24)	Medium (36)
Status (positive or negative)	Positive	Positive
Reversibility	N/A	
Can impacts be enhanced?	Yes	

Residual impacts:
Improved pool of skills and experience in the local area. However, due to relatively small number of local employment opportunities this benefit is likely to be limited.

Nature of Impact: Potential impacts on family structures and social networks associated with the presence of construction workers

The presence of construction workers poses a potential risk to family structures and social networks in the area. In addition there are a number of potentially vulnerable farming activities, such as livestock farming. The potential threat to farming activities is discussed below.

While the presence of construction workers does not in itself constitute a social impact, the manner in which construction workers conduct themselves can impact on the local community. In this regard the most significant negative impact is associated with the disruption of existing family structures and social networks. This risk is linked to the potential behaviour of male construction workers.

Employing members from the local community to fill the low-skilled job categories can help to reduce the risk and mitigate the potential impacts on the local communities. These workers will be from the local community and form part of the local family and social network and, as such, the potential impact will be low. The use of local residents to fill the low skilled job categories will also reduce the need to house construction workers on the site.

Phase: Construction phase

	Without enhancement	**With enhancement**
Extent	Local (3)	Local (2)
Duration	Short term (2)	Short term (2)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Low (24)**
Status (positive or negative)	Negative	positive
Reversibility	Reversible	
Can impacts be enhanced?	Yes, to some degree.	

Nature of impact: Potential noise, dust and safety impacts associated with movement of construction related traffic to and from the site The movement of heavy construction vehicles during the construction phase has the potential to damage roads and create noise, dust, and safety impacts for other road users (Mafraq-Irbid national road no.10) and local communities in the area. The potential impacts associated with the construction phase, specifically dust and generation of waste water. The potential social impacts associated with the construction related activities and the movement of construction related traffic can be effectively mitigated. As a result the significance with mitigation is rated to be Low Negative.		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (1)
Duration	Short Term (2)	Short Term (2)
Magnitude	Low (4)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Low (15)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	
Can impacts be mitigated?	Yes	
Residual impacts: None provided roads affected by construction activities are repaired		

Nature of impact: The activities associated with the construction phase, such as establishment of access roads, movement of heavy vehicles and preparation of foundations for the PV plant and the transmission line poles and foundations may damage farmlands and result in a loss of farmlands for future farming activities.

The activities associated with the construction phase have the potential to damage farmlands and result in a loss of land available for grazing. The significance of the impacts is to some extent mitigated by the fact that the farming activities on the site are confined to sheep and cattle farming as opposed to crops. The impact on farmland associated with the construction phase can therefore be mitigated by minimizing the footprint of the construction related activities and ensuring that disturbed areas are fully rehabilitated on completion of the construction phase.

	Without mitigation	With mitigation
Extent	Local (2)	Local (1)
Duration	Short term (2)	Short term if damaged areas are rehabilitated (2)
Magnitude	Minor - low (3)	Minor (2)
Probability	Highly probable (4)	Probable (3)
Significance	**Low (28)**	**Low (15)**
Status	Negative	Negative
Reversibility	No, in case of footprint associated with solar plant	
Can impacts be mitigated?	Yes	
Residual impacts: None. Once facility is decommissioned, current land use can be restored.		

7.3 Social Impacts Associated With the Operational Phase

The key social issues affecting the operational phase include:

Potential positive impacts

- Creation of employment and business opportunities. The operational phase will also create opportunities for skills development and training;
- Benefits associated with the establishment of a community trust;
- The establishment of renewable energy infrastructure; and
- Increasing the power transmission capacity to the AlHasan substation.

Potential negative impacts

- The visual impacts and associated impact on sense of place;

Nature of impact:

Creation of employment and business opportunities associated with the operational phase Based on the information from other Solar Facility projects the establishment of a 20MW plant and the transmission line of 33 kv for a distance of 13 km will create ~ 29 permanent employment opportunities during the 20 year operational phase. Of this total ~ 15 (50%) will be low skilled (security and maintenance), 5 (17%) semi-skilled and 10 (33%) skilled employees. The majority of the low and semi-skilled work opportunities associated with the operational phase is likely to be taken up by members from the local community. It will be possible to increase the number of local employment opportunities through the implementation of a skills development and training program linked to the operational phase.

Given the location of the proposed project, the majority of permanent staff is likely to reside in Husha and Buwaida areas. In terms of accommodation options, a percentage of the permanent employees may purchase houses in Husha or Buwaida, while others may decide to rent. Both options would represent a positive economic benefit for the area. In addition, a percentage of the monthly wage bill earned by permanent staff would be spent in the regional and local economy, which will benefit local businesses in these areas. The benefits to the local economy will extend over the 20-year operational lifetime of the project.

	Without mitigation	**With mitigation**
Extent	Local and regional (2)	Local and regional (3)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (30)**	**Medium (33)**
Status	Positive	Positive
Reversibility	N/A	
Can impacts be mitigated?	Yes	
Residual impacts: Skills development		

Nature of impact: Establishment of a community trust funded by revenue generated from the sale of energy. The revenue can be used to fund local community development. JSO has indicated that they are committed to Establish an educational fund to provide scholarships for the disadvantaged students from the local community. Experience has however also shown that Community Trusts can be mismanaged. This issue will need to be addressed in order to maximize the potential benefits associated with the establishment of a community trust.		
	Without mitigation	With mitigation
Extent	Local (2)	Local and Regional (4)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Moderate (6)
Probability	Probable (3)	Definite (5)
Significance	**Medium (30)**	**High (70)**
Status	Positive	Positive
Reversibility	N/A	
Can impacts be mitigated?	Yes	
Residual impacts: Overall improvement of social infrastructure & community services.		

Nature of impact: Promotion of clean, renewable energy The overall contribution of the proposed project plant to Jordan's total energy requirements will be small. In addition, the current application is not unique. In this regard, a significant number of solar developments are currently proposed in other parts of the country. The potential contribution of the proposed project plant should therefore be regarded as valuable, but should not be overestimated.		
	Without mitigation	**With mitigation** The provision of renewable energy infrastructure is in itself a mitigation measure)
Extent	Local, Regional and National(4)	Local, Regional and National(4)
Duration	Long term (4)	Long term (4)
Magnitude	Minor(4)	Low (4)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**Medium (40)**	**Medium (44)**
Status	Positive	Positive
Reversibility	Yes	
Can impacts be mitigated?	Yes	

Nature of impact: Visual impact associated with the proposed project and the potential impact on the areas rural sense of place. The components associated with the proposed project will have a visual impact and, in so doing, impact on the landscape and rural sense of the place of the area. Care therefore needs to be taken to ensure that the development of large renewable energy projects not impact on visual character and sense of place of the landscape.		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Minor (2)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Low (21)**
Status	Negative	Negative
Reversibility	Yes, solar facility can be removed.	
Can impacts be mitigated?	Yes	
Residual impacts: None, once facility is decommissioned the visual impact will be removed.		

7.4 Social Impacts Associated With the Decommissioning Phase

The social impacts associated with final decommissioned project are likely to be limited due to the relatively small number of permanent employees (29) affected. The potential impacts associated with the decommissioning phase can also be effectively managed with the implementation of a retrenchment and downscaling program. With mitigation, the impacts are assessed to be Low (negative).

The decommissioning phase will also involve the disassembly of the proposed project components and rehabilitation of the sites. The decommissioning phase will therefore also create additional, construction type jobs. Based on experience on other solar projects ~60 people will be employed during the decommissioning phase.

Nature of impact: Social impacts associated with retrenchment including loss of jobs, and source of income		
	Without mitigation	**With mitigation**
Extent	Local and Regional (3)	Local and Regional (3)
Duration	Medium term (4)	Medium term (4)
Magnitude	Moderate (6)	Moderate (6)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**Medium (44)**	**Medium (44)**
Status	Negative	Negative
Reversibility	Yes, assumes retrenchment packages are paid to all affected employees	
Can impacts be mitigated?	Yes	
Residual impacts: None		

7.5 Assessment of the Do Nothing Alternative

The 'Do-Nothing' alternative is the option of not constructing the proposed PV plant project. Should this alternative be selected, the predicted environmental impacts will not result. However, the local and regional socio-economic and environmental benefits of this renewable energy facility will not be realized. These benefits include:

- **Increased energy security:** The current electricity crisis in Jordan highlights the significant role that renewable energy can play in terms of power supplementation. In addition, given that renewable can often be deployed in a decentralized manner close to consumers, they offer the opportunity for improving grid strength and supply quality, while reducing expensive transmission and distribution losses.

- **Exploitation of our significant renewable energy resource:** At present, valuable national resources including biomass by-products, solar radiation and wind power remain largely unexploited. The use of these energy flows will strengthen energy security through the development of a diverse energy portfolio.

- **Pollution reduction:** The releases of by-products through the burning of fossil fuels for electricity generation have a particularly hazardous impact on human health and contribute to ecosystem degradation.

- **Climate friendly development:** The uptake of renewable energy offers the opportunity to address energy needs in an environmentally responsible manner and thereby allows Jordan to contribute towards mitigating climate change through the reduction of greenhouse gas (GHG) emissions. The project is expected to generate approximately 48 gigawatt hours (GWh) of electricity per year. Jordan's current carbon dioxide emission performance (from fuel combustion) is 0.64kg carbon dioxide per kilowatt hour (CO_2/kWh) (according to International Energy Statistics, 2013). Using this factor, the project is estimated to reduce 30,720 tons of CO_2-eq/year.

- **Support for international agreements:** The effective deployment of renewable energy provides a tangible means for Jordan to demonstrate its commitment to its international agreements under the Kyoto Protocol.

- **Employment creation:** The sale, development, installation, operation and maintenance and management of renewable energy facilities have significant potential for job creation in the local communities and surrounding.

- **Acceptability to society:** Renewable energy offers a number of tangible benefits to society including reduced pollution concerns, improved human and ecosystem health and climate friendly development.

The No-Development option would represent a lost opportunity for Jordan to supplement its current energy needs with clean, renewable energy. However, as indicated above, the overall contribution of the two components of the proposed project in Husha and Buwaida to Jordan's total energy requirements will be relatively small. In addition, the current application is not unique. The potential contribution of the proposed project should therefore be regarded as valuable, but should not be over-estimated.

The No-Development option would also result in a loss in employment opportunities associated with both the construction and operational phase. In addition, the benefits for the local community in the area associated with the establishment of a Community Trust funded by revenue generated from the sale of energy from the proposed project would be forfeited. The revenue from the proposed project can be used to support a number of social and economic initiatives in the area. These benefits would be forgone if the proposed project is not developed. Given the limited economic opportunities in the area this would represent a negative social cost for the local community.

Nature of impact: The no-development option would result in the lost opportunity for Jordan to supplement its current energy needs with clean, renewable energy. The No Development option would also result in the loss of the benefits to the local community and economy associated with the creation of employment opportunities and the establishment of a Community Trust		
	Without mitigation	With mitigation
Extent	Local-national (2)	Local-national (3)
Duration	Long term (4)	Long term (4)
Magnitude	low (4)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium(30)**	**Medium (33)**
Status	Negative	Positive
Reversibility	Yes	
Can impacts be mitigated?	Yes	
Residual impacts: None		

The "Do Nothing" alternative is therefore not preferred as Jordan needs to diversify electricity generation sources, to which this project will contribute.

8 Study Team[7]

Al Shamil Engineering / EIA study team consists of the following key personnel:

- Senior Environmentalist (Study team leader): Dr. AbdulAziz M. Weshah
- Water Resources expert: Dr. AbdulAziz M. Weshah, Mr. Salameh Khraisha
- Senior Environmentalist / Air Quality expert: Ms. Sawsan A. Zawahreh
- Biodiversity expert: Mr. Ehab Eid, Mr. Hazim Salameh , Ms. Suha Nsour
- Archeologist: Dr. Mohammad Waheeb
- Socio-Economist: Mr. Omar Weshah

[7] CVs of the study team are provided in annex (7)

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