Tafila Wind Energy Project

Tafila Governorate

(Hashemite Kingdom of Jordan)

Environmental and Social Mitigation and Management Plan (ESMMP)

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Project Company:

JWPC

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List of abbreviations

ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Mitigation and Monitoring Plan
HGV	Heavy goods vehicles
IBA	Important Bird Area
JWPC	Jordan Wind Project Company
MM	Mitigation measure
RSCN	Royal Society for the Conservation of Nature
WTG	Wind Turbine Generator

1. Introduction

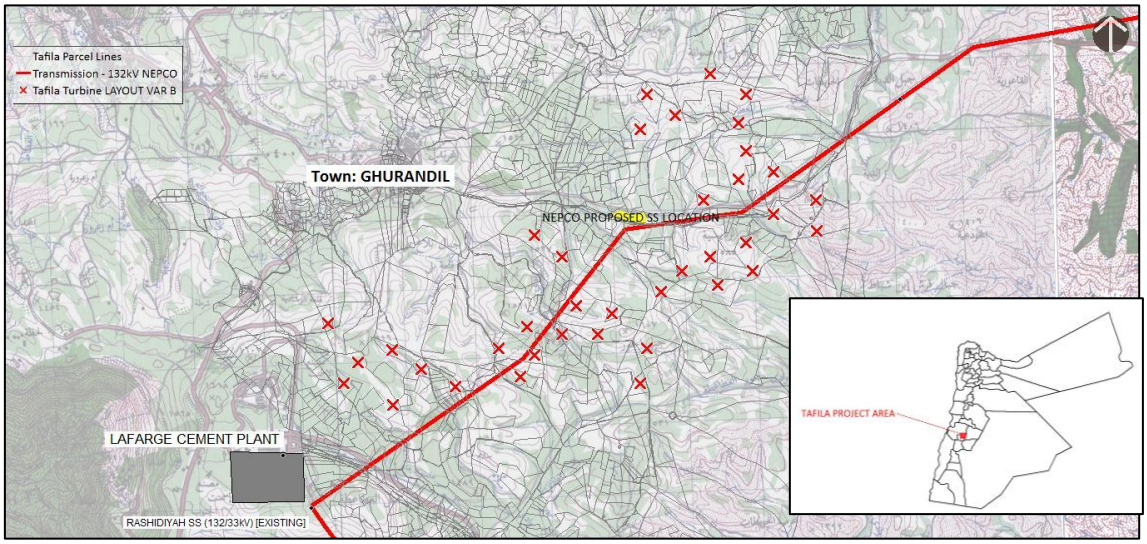
As a supplement to the Environmental and Social Impact Assessment of the Tafila wind farm, the Environmental and Social Mitigation and Monitoring Plan (ESMMP, or plan) has been developed. This ESMMP is a stand-alone document, and summarizes the impact identification and assessment results, as well as the mitigation and monitoring measures throughout the project lifetime.

The mitigation and monitoring measures to be taken to reduce or eliminate potential negative impacts arising from individual or combined activities are described for each phase of the Project in this document. The mitigation measures are numbered throughout the report in the following way: "MMxx". Continuous improvement in the identification and mitigation of environmental impacts is the desired outcome from the plan, with a corresponding benefit to the region from the improved environmental performance of the project.

The plan is a working document, and will be updated and expanded in line with specific requirements of Jordanian law, as well as items necessitated by the specific characteristics of the project area. Responsibility for the drafting of the plan and ultimate adherence to the goals of the plan is the task of the Sponsor, JWPC. Actual implementation of the measures required in the plan will be borne by the Construction / Operations and Maintenance Contractor, and the obligation to fulfill the guidelines will be included in contract agreement docs between the Sponsor and Contractor(s).

2. Project summary

The proposed project is a 117 MW wind energy project (in the further referred to as “wind farm” or “the Project”) to be located in rural land in the Governorate of Tafila. The project is located to the northeast of the existing Lafarge Rashidiya Cement plant, and east of the town of Gharandil. The development group and sponsor for the Tafila Wind Project is the Jordan Wind Project Company (JWPC).



This wind farm is aimed to supply Jordan with approximately 388 GWh/a of clean, renewable and environmental friendly electricity and will save approximately 245,992 t CO_2/a). In addition to CO_2 savings, the project will save approximately 1.3 million m³ of water per year which equals the consumption of 400.000 households. The water savings are related to savings of fuel plants which consume a lot of water for cooling.

The area was selected based on its low intensity of human habitation, proximity to existing transmission infrastructure, expected favorable wind resource, and its low impact on the nature and environment. The common usage of the area of the Tafila wind farm is some seasonal grazing activity (sheep, goats), and agriculture (wheat) in the small areas. There are no permanent dwellings or other structures in the project area that would be affected by the construction or operation of the project. The site is periodically used by farmers and shepherds who camp in the region during summertime.

There are no water sources available at surface level. Water for the area is obtained from wells in the nearby town of Gharandil, and from wells located to the north of the project area.

The project components will include the following:

- 38 wind turbine generators (WTG);
- 38 reinforced concrete foundations;
- One project substation (electrical substation);

- Electrical protection, transformation, and metering equipment;
- Underground electrical & communication cables;
- Overhead electrical & communication cables;
- Access roads;
- Crane pads and laydown areas;
- Permanent wind measurement tower;
- Permanent warehouse for storing of components
- Temporary construction compound.
- Storage Area for Spare Parts

The Project will be developed and executed in four phases.

- Pre-construction, until first quarter of 2013 – e.g. site assessment, wind measurement, grid assessment, environmental and social impact assessment;
- Construction, until 2014;
- Operation until 2034;
- Decommission in 2034 – deconstruction of the entire wind farm and restoration of the area.

3. Roles and Responsibilities

3.1. Jordan Wind Project Consortium

JWPC is the sponsor and developer of the project, and is the named party in all authorizations, permits, and agreements for the project. It is responsible for the contracting of the construction works for the project, as well as the procurement of financing.

JWPC will itself, or through consultants / engineering acting on its behalf, appoint an Environmental Policies Representative (EPR), which will monitor the performance of the contractor for adherence to the measures outlined in this document.

3.2. Contractor [Vestas Italia]

The contractor will be responsible for the design of the plant, as well as construction works through to commissioning. At point of full commissioning, the works will be handed over to the owner, JWPC, though the Contractor will assume the operations responsibility for the plant on behalf of the Owner. The Contractor, through its appointed Environmental Representative, will be responsible for complying with the provisions of the ESMMP, as well as guidelines for Health, Safety, and Environmental performance.

3.3. Record Keeping

Record keeping will be centralized at the Project Construction Compound. The record keeping system will be managed by the Sponsor or through the consultants / engineering acting on its behalf. Records will be maintained in physical and electronic format.

Example of records to be maintained include:

- ESIA;
- ESMMP;
- Permits / Authorizations;
- Jordanian Laws on Health, Safety, Environmental;
- Training Materials (English, Arabic);
- Incident Reports;
- Monitoring Reports;
- Audit Reports;
- Operating Manuals for Tools, Equipment (English, Arabic);
- Emergency Procedures;
- Contact Lists.

4. Training

Training of site personnel will be organized prior to start of construction so as to make all personnel engaged on site works aware of the environmental and safety requirements of the project. The training will be organized and implemented by either:

- JWPC;
- Consultants / engineering acting on behalf of JWPC;
- Contractor [Vestas Italia].

The trainings will be held in either English, Arabic, or another language as required by the nationality of the site workers. The trainings will be accompanied by material which will be given to the site workers, and records of the training sessions completed by employees will be maintained at the Project Construction compound.

4.1. Goals

The goals of the training program for the employees will be to:

- Inform the employees of environmental, health and safety requirements during construction;
- Emphasize methods and techniques that can be used to reduce impact and improve safety;
- Make participants aware of environmental conditions which may be unsafe or reason for construction pause;
- Enable employees to respond to emergency situations in a safe and effective manner;
- Improve communication between all parties engaged in site work related to the environmental and safety aspects of the project.

5. Auditing

5.1. Introduction

In order to measure compliance with the requirements of the ESMMP, ongoing audits will be agreed and organized between the Sponsor and its consultants, as well as the Contractor. The audits will be conducted on agreed intervals (i.e. monthly, weekly, daily, random), with the results of audits to be compared over time to gauge rate of improvement in performance areas.

In the case of decline of measurable performance areas, additional training, incentive programs, or other systems can be agreed and implemented to improve performance to acceptable levels, with a goal of continuous improvement in the metrics over time.

The program of auditing will undergo revision and expansion continuously in line with ongoing discussions with the Contractor.

6. Biodiversity

6.1. Introduction

A biodiversity study was conducted, based on one year field survey and a detailed desktop study.

Although the project area does not belong to the Jordan Rift Valley, the main and the only major migratory route for birds in the Middle East, the Dana important bird area (IBA), as well as the Dana nature reserve, are close to the planned wind farm. There is no main flight route crossing the planned wind farm area, even so birds were monitored on site

During the two observed main migration seasons, researchers of this study did not observe or record heavy raptor or stork migration in neither spring nor autumn migration seasons. The reason for this is most likely due to the fact that the area is heavily disturbed by farming, grazing, hunting, nearby cement mining operations, as well as local resident's constant movements and roads.

Species that were observed during the monitoring program are listed in the ESIA for the Tafila wind farm.

To secure that rare and endangered species are not threteaned by the project the construction sites of the WTG and of the roads are preinspected before the construction will be conducted. If possible, identified species that are endangered or rare and that are directly effected by the project will be relocated to a place with similar conditions.

6.2. Mitigation and monitoring measures – Biodiversity

Table 6-1: Mitigation and monitoring measures during construction phase

Specie	Impact	Description	Mitigation Measure [MM]	Monitoring measures
Flora	Removal of topsoil	It is expected that during the construction activities the topsoil will be removed. Removing the topsoil, which has a high nutrient content, will cause the loss of micro-habitats for common vegetation, reptiles, small mammals and local birds such as larks and other passerines.	• To limit construction activities within the wind farm site; [MM1] • Reduce / optimize amount and size of new roads and transmission cables as much as possible; [MM2] • Store the natural soil at special sites and reuse it when back-fill activities are needed; [MM3] • Shift natural vegetation and rich soil of the construction sites to nearby areas. [MM4] • Use good construction activities and minimize clearing of natural vegetation [MM5] • Ensuring that locally obtained construction materials come from legal and environmentally sustainable sources. [MM6] • Restore cleared areas with natural top soil where feasible [MM7] • Avoid creation of new landscape [MM82] • Good management of debris in allocated sites to be reused for fill activities; [MM83]	• Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.

Specie	Impact	Description	Mitigation Measure [MM]	Monitoring measures
	Collecting wood by workers	Collecting wood from natural plants and vegetation for household fire by workers. This impact on the vegetation is of low magnitude level due to the lack of woods in this site and due to the fact that households are not foreseen in the project area. However, there is a pine artificial forest near Busaira and Gharandil and some shrubs may be used by workers during the construction.	• To prohibit workers from collecting wood especially in forested areas near villages; [MM8] • Vestas as a sole contractor during the construction period is working under the ISO 14001 Environmental standard and will strictly control its own workers as well as subcontracted worker related to environmental behavior on site. [MM9]	• Regular auditing of mitigation measures by contractor under supervision from the sponsor; • Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.
	Habitat destruction	In conjunction with the project, roads will be built. Due to these roads, a low magnitude impact on the vegetation that was found in the site is expected. A higher impact is not expected since the site already has many roads which are used by locals.	• Reduce / optimize amount and size of new roads and transmission cables as much as possible; [MM2] • Shift natural vegetation and rich soil of the construction sites to nearby areas. [MM4] • Decommissioning of the temporary assembly areas and restoring the original conditions. [MM10]	• Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.

Specie	Impact	Description	Mitigation Measure [MM]	Monitoring measures
	Solid and liquid waste	Solid and liquid wastes will be either domestically generated or result from earth-moving and assembly activities during construction. Liquid waste is defined as grey water, oil and any lubricants; If such wastes were not handled adequately, the wadi beds will be contaminated during runoff which would also affect the flora in the area. Additionally such waste may attract animals to the area. The significance of this impact may be of medium level, especially on the surrounding area to the proposed locations of the project, like the wadi systems nearby the site.	• Collect all wastes, solid and liquid, in sealed containers to be disposed in proper disposal sites; [MM11] • Vestas is working under ISO 14001 accreditation for environmental management. It is forced to care also for all its subcontractors. [MM9]	• Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.
	Dust	Dust generated during construction phase by moving vehicles and construction work.	• Cover each spot where excavated material is stored when climate conditions requires to. [MM12] • Dust control by usage of dust suppression substances. [MM13]	• Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.

Specie	Impact	Description	Mitigation Measure [MM]	Monitoring measures
Fauna	Noise	Noise of the construction may frighten animals currently residing on the site to leave and / or dissuade new animals from coming onto the site. However the construction activities are for a limited period of time and the contractors must be abiding with the regulations of protection from noise.	• Reduce loud construction activities to normal working hours during daytime as much as possible; [MM11] • Reduce vehicle movements to a minimum extent. [MM14]	• Regular auditing of mitigation measures by contractor under supervision from the sponsor; • Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.

Specie	Impact	Description	Mitigation Measure [MM]	Monitoring measures
	Light	During night-time large vehicles will bring the wind farm components to the site. These vehicles generally drive during night-time to reduce the traffic disturbance by large trucks in the day. The light and noise may scare animals into leaving the site. These night activities on the site may have also the effect that animals get killed by accident while moving equipment on the construction compound. This impact is of low magnitude.	• Limitation of drives during night. [MM15]	• Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.
	Accidental killing	Accidental killing of animals by vehicles from service.	• To report any accident to JWPC. [MM16]	• Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.
	Bat casualties	Bat appearance on the project site was not recorded up to date. Nevertheless the literature review shows that bat habitats exist in the Dana Biosphere Reserve.	• To proof the appearance of bats on the project site further investigations have to be conducted. The project developer will place a bat detector on the project site to monitor any movements from these species. If the appearance of bats is proofed, adequate mitigation measures have to be implemented [MM17]	• Responsibility to monitor bat activities on the project site lies within the tasks of the sponsor.

Specie	Impact	Description	Mitigation Measure [MM]	Monitoring measures

	Hunting	Disturbances of species due to construction work may lead to changed living modes of wildlife such as chukars, porcupines, badgers and other. A possible change may be the shifting of the normal feeding time to the day. Workers of the wind farm construction team may be attracted by these animals and hunt them on the site.
		
		This impact is of low magnitude due to the low abundance of game species in the proposed locations for the project. However, proper control measures to avoid this happening in the project site must be in place.
			• To prohibit workers from hunting and produce awareness materials such as: [MM18]
			  ◦ Signs;
			  ◦ Training manuals and material;
			  ◦ Posters;
			  ◦ Brochures;
			  ◦ Toolboxes.
			
			• Vestas is working under ISO 14001 accreditation for environmental management. It is forced to care also for all its subcontractors. A Health and Safety and Environmental Manager must be on-site during the construction works. [MM9]
				• Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.

Specie	Impact	Description	Mitigation Measure [MM]	Monitoring measures
	Solid and liquid wastes	Domestic wastes may attract some wildlife species to the site which may initially threat the workers on the site. The waste may threaten the animals as well, if it is contaminated with hazardous wastes produced by the construction activities. This impact is of medium magnitude.	• To collect all wastes in sealed containers; to be disposed in proper disposal sites; [MM11] • To prevent feral and wild animals from using the solid waste sites for feeding. [MM19]	• Regular auditing of mitigation measures by contractor under supervision from the sponsor; • Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.

Table 6-2: Mitigation and monitoring measures during operation phase

Specie	Impact	Description	Mitigation measure [MM]	Monitoring measures
Flora	Solid and liquid wastes	Domestic wastes would be minimal during operation phase. The oily waste from maintenance work of the engines may be of importance although the quantities are not significant. The operator must ensure proper and adequate management of such waste according to the regulations and best practices.	• Collect all wastes in sealed containers to be disposed in proper disposal sites. [MM11]	• Responsibility to limit impact lies within the tasks of the Contractor and the sponsor.

Specie	Impact	Description	Mitigation measure [MM]	Monitoring measures
	Destruction of flora	During the operational phase the likelihood of having workers and vehicles that may leave given routes and destroy the vegetation in doing so is very small due to the limited activities in comparison to the construction phase.	• Prohibit leaving the roads and crane pads with vehicles unless major maintenance works will have to be performed. [MM20]	• Regular auditing of mitigation measures by contractor under supervision from the sponsor; • Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.
Fauna	Displacement and habituation	Displacement of resident birds such as larks, wheatears, warblers and other passerines is possible. Displacement could deprive the birds mentioned above from feeding and breeding on the project site due to disturbance.	• Conduct follow-up researches on the effects of the project on the fauna. [MM21]	• Follow-up research will be conducted by RSCN under supervision from the sponsor
	Hunting by workers	This impact is expected to be of low magnitude level due to the infrequent interaction of workers during the operational phase with the surrounding environment during nighttime.	• To prohibit workers from hunting and produce awareness materials such as: [MM18] • Signs; • Training manuals and material; • Posters; • Brochures; • Toolboxes.	• Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.
	Accidental killing	Impact from accidental killing, disturbance and noise is of low magnitude level since it's limited to the movement of machinery especially by vehicles moving around the site during the night-time which will rarely happen during this project phase.	• Report any accident to JWPC. [MM16]	• Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.

Specie	Impact	Description	Mitigation measure [MM]	Monitoring measures
	Disturbance and noise	Vehicles on the site may cause disturbance on the fauna, especially on species that got currently used to the WTG.	• Reduce vehicle movements to a minimum extent. [MM14]	• Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.
	Habitat alteration and fragmentation	Habitat alteration resulting from wind energy projects include changes in plant communities that would affect avifauna resident birds such as larks, sirens, bulbuls, Palestine sunbird, Chukar and others.	• Minimize intervention as much as possible [MM22]	• Responsibility to limit impact lies within the tasks of the sponsor.
Avifauna	Collisions	Collisions between birds of prey, such as passerines, hoopoe, larks and shrike, which fly at low altitudes up to 100 m, and wind turbines, can happen at wind energy projects. As with electricity projects in general, collisions with transmission lines may also occur. Furthermore collision with guy wires fixing a 100m meteorological mast to the ground may occur.	• Choose appropriate turbine tower; [MM23] • Choose appropriate wind turbine height; [MM24] • Choose wind farm layout with least impact on known avifauna flight paths; [MM25] • Underground cables instead of overhead will be constructed; [MM26] • Paint each blade with 2 red stripes, each 6 m; [MM27] • Conduct periodical bird monitoring throughout the project lifetime to analyze impacts of the wind farm on the avifauna; [MM28] • Mark guy wires with barrier tape for better visibility. [MM29]	• Responsibility for the avifauna monitoring lies within the tasks of the sponsor as well as within the task of the monitoring contractor.
		Use good maintenance practices	• Fix WTGs that birds and bats are not able to enter the turbines for refuge or to nest there [MM30}	•

Specie	Impact	Description	Mitigation measure [MM]	Monitoring measures

	Electrocution	Wind power plants generate electricity. The electricity is transferred to a substation via distribution lines or underground cables. In the substation the voltage is stepped up and the electricity is transferred by transmission lines to another substation where the electricity is used. The voltage is stepped down again and transferred by distribution lines to various customers.
		
		Although lower in voltage, distribution lines are more often associated with bird mortality than transmission lines. The reason for this is the closer spacing of their electrical conductors (2 to 6 feet, versus 7 to 30 feet) [BirdLife International, 2003]. Eagles are particularly susceptible to this danger because their body size and wingspan are large enough to span the distance between the conductors.
			• The risk of electrocution to raptors can be reduced by using underground power lines. These will be used to connect the WTG with the substation. If the use of underground power lines is not possible due to soil conditions, raptor-safe designs of overhead power lines will be installed. The connection between substation and transmission line will be an overhead power line. As the transmission line and the substation are not far apart, this connection will be short. For this connection raptor-safe power lines will be installed; [MM31]
			• Other mitigation measures that could be used to minimize the risk of mortality from collision with new transmission lines or during upgrades to existing distribution lines include: [MM32]
			  ◦ The installation of bird flight diverters where new transmission line crosses; [MM33]
			  ◦ The use of perch guards or insulated cover-ups on new devices; [MM34]
			  ◦ Inspection and insulation of jumper/ground wires; [MM35]
			  ◦ Construction of new transmission lines such that all transmission conductors are a minimum of 60 inches apart; [MM36]
				• Responsibility to limit impact lies within the tasks of the sponsor.

7. Geology, hydrology and hydrogeology

7.1. Introduction

The selected project site is located in a desert-like area with numerous hills composed of unconsolidated soil and rocky ground of different grain-sizes (sand, gravel, pebble-size and larger stones of at least 5-10 cm diameter, basically made of the mineral chert).

The general vegetation in the project area is sparse. Buildings and trees in the site are very limited. Only rural houses and trees close to the nearest village exist permanently in the area.

Water resources in the study area consist of three sources, namely groundwater resources, surface water and treated wastewater sources. Groundwater resources in the study area are represented by the pumped wells and the springs encountered in the catchment area, while surface water includes spring flow and flood flow. It is to be noted that there are no spring water flows in the immediate project area, and that the only surface water which would possibly be present would be in the form of flood flows which would temporarily result from rain or snowfall in the project area.

7.2. Mitigation and monitoring measures

Table 7-1: Mitigation and monitoring measures for geology and water resources

Impact of	Mitigation measure [MM]	Monitoring measure
Wadi crossings by construction traffic	Construction when no water flow is expected and allowance of drainage. [MM37]	◎ Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.
Water demand for construction camp	Minimize water consumption / abstraction as much as possible. [MM38]	◎ Regular auditing of mitigation measures by JWPC; ◎ Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.
Wastewater production from construction camp	A completely closed cesspool must be built to collect domestic wastewater resulting from workers. It must be emptied frequently and transported to the nearest municipal wastewater treatment plant. [MM39]	◎ Regular auditing of mitigation measures.
Use of water for dust, raised by vehicles and decommissioning work may lie down on plants and hinder their photosynthetic processes	In order to reduce the use of water for dust-reduction purposes, excavated piles of soil will be covered with tarpaulins, where possible, instead of being watered to reduce dust production. [MM40] Special dust suppression material could be used instead of water. [MM13]	◎ Regular auditing of mitigation measures by the contractor; ◎ Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.
Rainwater and snowmelt runoff in the winter	Minimize the flow of excess and debris soil to wadis (sedimentation), manage drainage system. [MM41]	◎ Regular auditing of mitigation measures by the contractor.

Impact of	Mitigation measure [MM]	Monitoring measure
Soil excavation for foundations and construction	Nutrient rich top soil can be used provided that erosion is avoided. [MM42] Deeper parts, such as limestone, shall be transferred for reuse elsewhere in filling or stones crushing. [MM43]	• Regular auditing of mitigation measures by the contractor.
Erosion caused by heavy rainfall	Minimizing the amount of earth disturbed during construction; [MM44] Avoiding construction on steep slopes wherever appropriate; [MM45] Designing erosion-control structures adequate to the task; [MM46] Remove excess soil from sites of towers on a regular basis; [MM47] Cover excavated soil with suitable tarpaulins. [MM40]	• Regular auditing of mitigation measures by the contractor; • Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.

Impact of	Mitigation measure [MM]	Monitoring measure
Pollution of water through spills of leaks of fuels and oils	Inspection of trucks that stay on-site for long periods (such as excavation machinery and cranes); [MM48] Special considerations for fuel trucks; [MM49] Spill clean-up procedures must be in place; [MM50] Ensure safe storage and transfer of oils and waste oil. [MM51]	• Regular auditing of mitigation measures by the contractor; • Responsibility to limit impact lies within the tasks of the Contractor, under supervision from the sponsor.
Domestic solid waste resulting from workforce	It must be collected in special containers and transported periodically to the nearest solid waste disposal area. [MM11]	• Regular auditing of mitigation measures by the contractor.

8. Noise

8.1. Introduction

Noise from wind turbines has the potential to cause annoyance to people living near such installations. Sensitive noise receptors are considered to be dwellings, but not roads or footpaths. The planned wind farm is located in a remote area, where no occupied dwellings exist within a distance of about 1.1 km.

The Vestas V112 reaches its highest noise emission level of 106,5 dB at a wind speed of 7 m/s; at wind speeds above 7 m/s the turbine does not become louder.

Noise which may impact the surrounding dwellings will occur during:

- The construction phase from machinery and traffic;
- The operational phase of the WTG;
- The decommissioning phase from machinery and traffic.

8.2. Mitigation and monitoring measures

Table 8-1: Mitigation and monitoring measures for noise impacts

Impact	Mitigation measure [MM]	Monitoring measures
Noise by construction work	• Limit the working hours from Saturday to Thursday 7 a.m. – 7 p.m. if possible; [MM52]. Indeed Some flexibility in working hours may be required during the delivery, erection of turbines and depending on weather conditions. Final time schedule of the transport movements will be clarified with the authorities and communities. • Inform locals on the different construction steps; [MM53] • Equipment will be turned off when not in use; [MM54] • The staff will be informed of any noise sensitive receptors in the vicinity of the site, and they will be advised regularly by the Site Manager of the quietest best practice methods of operating plant and tools and to report any damage to noise control measures immediately when they are identified; [MM55] • Reduce noise for workers. [MM56]	• Hearing protection shall be issued to staff in working areas where noise levels exceed the permissible standards; • Staff shall be made aware of noise risks associated with the construction contract and the need for hearing protection when the situation requires it; • The site construction manager will monitor and manage construction noise as appropriate; • A record of complaints and corrective action will be kept and made available for inspection if required; • Responsibilities lay within the tasks of the EHS manager of the contractor and the Sponsor Project Manager.

Impact	Mitigation measure [MM]	Monitoring measures
Noise by WTG operation	• The turbines are not foreseen to be operated in a noise reduced mode. The noise limits of the Jordan law are not exceeded. In case of any unforeseen reason it is possible to active noise reduced operation at the turbines. ; [MM57] • Similar to the mitigation that will be carried out for shadow flickering, maps of noise propagations will be published on information boards within the wind farm to allow seasonal residents as Bedouins to build up their tents in less affected areas of the wind farm [MM58] • The wind farm layout in Tafila was optimized in order to minimize the impact of noise by keeping a sufficient distance to the surrounding properties. This has been one of the key factors during the design process [MM59]	• Two noise measurements of the turbine emissions will be conducted by certified noise measurement companies; • A noise measurement of the immissions will be conducted at the nearest receptors when a) if the noise measurements of the emissions is exceeding the guaranteed sound power level or b) when the authorities requires it ; • If a problem with noise is occurs, then further mitigation measures must be investigated; • A record of complaints and corrective action will be kept and made available for inspection if required; • Responsibilities lay within the tasks of the EHS manager of the contractor and the Sponsor Project Manager. • Even though best efforts were made to collect and determine the background noise in the town of Gharandil by measurements in accordance to the Scoping report, the gathered background noise data are not considered suitable for the exact determination of the background noise level. Further additional noise measurements with first class equipment could be undertaken at several noise sensitive areas to allow proper determination of the background noise levels at various receptors. The proper determination of background noise would allow final identification of adherence to further international guidelines including consideration of background noise.

Impact	Mitigation measure [MM]	Monitoring measures
Noise by decommissioning work	• Limit the working hours from Sunday to Thursday 7:00 – 19:00 when possible; [MM52] • Inform locals on the different decommissioning steps. [MM53]	• The site construction manager will monitor and manage construction noise as appropriate; • A record of complaints and corrective action will be kept and made available for inspection if required; • Responsibilities lay within the tasks of the EHS manager of the contractor and the Sponsor Project Manager.

9. Shadow flicker

9.1. Introduction

Shadow flicker may occur when the rotating blades of a wind turbine pass through the sun's rays seen from a specific location. This creates a fast-moving shadow with a "flicker" effect, which can be seen inside of homes and other buildings. The impact on nearby dwellings depends on conditions such as weather, topography, or the distance between the turbine and the building.

Predicted exposure of a particular building to this shadow flicker effect is measured in minutes per day and cumulative annual hours.

9.2. Mitigation and monitoring measures

The shadow assessment has shown that, due to the movement and the different positions of the sun, it is not possible to exceed the annual and daily limits of accumulated shadow flicker at the closest receptors. Following there is no need for mitigation measures.

If, by any chance, the limits are exceeded by the planned project, turbines have to be switched-off. Seasonal residents are temporary passing the project area and might rear sheep and goats between the WTG. To offer the possibility of choosing the best spots to up build tents for the shepherds a shadow map was calculated and will be published on information boards in the wind farm. This map recommends areas between the turbines where the impact of shadow flickering is less significant.

10. Air quality

10.1. Introduction

This chapter describes the potential impacts and effects on air quality associated with Tafila wind farm.
The primary impact on air quality caused by the planned wind farm will be dust which is created and dispersed during the construction and decommissioning phases of the project. Excavations and underground construction works expose soil to the wind, which may be blown away as dust. Vehicles driving on the gravel roads on the site may also generate dust.

This dust is distributed by the air and may come to rest on nearby houses or other buildings, potentially creating a nuisance or health problem for people who frequent these locations.

The production and distribution of dust also depends in large part on the weather. Dry, windy conditions encourage dust production and may distribute the produced dust further, while wet weather or low wind speeds discourage the production of dust.

10.2. Mitigation and monitoring measures

Dust sources on the project site are located at approximately four times more than the distance at which sensitivity is considered to be low to negligible. In addition to this, baseline measurements show that the air quality in the vicinity of the project site is of good quality, which decreases the sensitivity of the receptors.

Because the site can be described as desert-like, prone to long periods of dry, windy weather, it is possible that unforeseen, extreme weather cases could lead to dust control being needed. In these cases, any or all of the measures may be employed at the discretion of the construction supervisor.

Table 10-1: Mitigation and monitoring measures for impacts on the air quality

	Impact description	Mitigation measure [MM]	Monitoring measures
Construction phase	Construction work and vehicles raise dust which will lie down on plants in the close surrounding covering the vegetation.	• Any storage on site of aggregate or fine materials will be properly enclosed and screened so that dust escape from the site is avoided; [MM60] • All vehicles carrying bulk, dust-producing materials into or out of the site will be covered to prevent dust emission; [MM61] • Minimize dust production by spray of dust suppression substances in the operational areas when climate conditions require it; [MM13] • Vehicles shall keep to a speed limit of 20 km/h on gravel access roads on site to minimize dust generation; [MM62] • Drivers of construction vehicles must be instructed not to leave them idling, in order to reduce the emission of exhaust fumes; [MM63] • If for any reason the above named measures are not effective at preventing dust emissions from leaving the site, the project manager will suspend the works or define increased measures giving rise to the emissions until weather conditions change or effective dust control measures have been implemented; [MM64]	• A state of the art air quality measurement is conducted during construction; • Regular auditing of mitigation measures; • A record of complaints and corrective action will be kept and made available for inspection if required; • Responsibilities lay within the tasks of the EHS manager of the contractor and the Sponsor Project Manager.

	Impact description	Mitigation measure [MM]	Monitoring measures
		• Earth moving works should not be conducted at times with strong easterly winds that dust is not blown in direction of the close residential areas Gharandil and Lafarge Rashidiya settlement [MM65]	
Operation phase	Dust may be raised by moving maintenance vehicles	• Vehicles shall keep to a speed limit of 20 km/h on gravel access roads on site to minimize dust generation; [MM62] • Drivers of construction vehicles must be instructed not to leave them idling, in order to reduce the emission of exhaust fumes. [MM63]	• A record of complaints and corrective action will be kept and made available for inspection if required; • Responsibilities lay within the tasks of the EHS manager of the contractor and the Sponsor Project Manager.
Decommissioning phase	Decommissioning work and vehicles raise dust which will lie down on plants in the close surrounding covering the vegetation.	• All vehicles carrying bulk, dust-producing materials into or out of the site will be covered to prevent dust emission; [MM61] • Minimize dust production by spray dust suppression substances in the operational areas when climate conditions require it; [MM13] • Vehicles shall keep to a speed limit of 20 km/h on gravel access roads on site to minimize dust generation; [MM62] • Drivers of vehicles must be instructed not to leave them idling, in order to reduce the emission of exhaust fumes; [MM63] • If for any reason the above named measures are not effective at preventing dust emissions from leaving the site, the	• Regular auditing of mitigation measures; • A record of complaints and corrective action will be kept and made available for inspection if required; • Responsibilities lay within the tasks of the EHS manager of the contractor and the Sponsor Project Manager.

	Impact description	Mitigation measure [MM]	Monitoring measures
		project manager will suspend the works or define increased measures giving rise to the emissions until weather conditions change or effective dust control measures have been implemented; [MM64]	

11. Cultural heritage and archaeology

11.1. Introduction

An archaeological survey was carried out by a team of specialists in order to establish the archaeological baseline data. The desktop stage of this study was based on literature review, research of databases of archaeological locations, aerial map surveys, and interviews with experts in the field of archaeology. The desktop stage was followed by physical surveys of the project area, during which time the site was thoroughly examined by representatives from the Jordan Department of Antiquities, and locations of archaeological findings were logged in order to create a full database of critical areas in the project area.

The results of the archaeological survey show that archaeological artifacts and remains are widely spread and common on the wind farm site, as well as throughout the mountainous area on Jordan's western half. Accordingly, the preliminary locations of a number of WTG were found to conflict with archaeological findings, and alternative locations were chosen.

Proper mitigation measures to protect all the archaeological sites will be implemented during the construction phase to ensure areas are protected to the fullest degree reasonably possible.

11.2. Mitigation and monitoring measures

Table 11-1: Mitigation and monitoring for impacts on cultural heritage during construction

Impact	Mitigation measure [MM]	Monitoring Measure
Direct vehicle impact on archaeological remaining, such as compaction, disturbance, wheel-slip, collision.	• Identification of sensitive areas to contractors; [MM66] • Keep vehicles on the construction site and on the tracks. [MM67]	• Regular auditing of mitigation measures; • Responsibility lies within the tasks of the Contractor, under supervision from the sponsor.
Removal of archaeological layers by excavation	• Avoidance of known sensitive areas; [MM68] • Oversight during excavation by archaeological experts. [MM69] • Prepare and implement chance-find procedure in line with IFC Performance Standard 8 [MM70]	• Regular auditing of mitigation measures; • Responsibility lies within the tasks of the Contractor, under supervision from the sponsor.
Vibration from vehicles	• Keep vehicles on the construction site and on the tracks. [MM67]	• Regular auditing of mitigation measures; • Responsibility lies within the tasks of the Contractor, under supervision from the sponsor.

Impact	Mitigation measure [MM]	Monitoring Measure
Creation of tracks and routes	• Instruct contractor to stay on the construction site and on the tracks. [MM71]	• Regular auditing of mitigation measures; • Responsibilities lay within the tasks of the Sponsor Project Manager.

Table 11-2: Mitigation and monitoring for impacts on cultural heritage during operation

Impact	Mitigation measure [MM]	
Visible presence of turbines, track-ways, crane pads, etc.	• Design features for minimum impacts. [MM72]	• Not required.
Direct impacts on archaeological sites	• Keep vehicles on the construction site and on the tracks. [MM67]	• Regular auditing of mitigation measures; • Responsibility lies within the tasks of the Contractor, under supervision from the sponsor.

12. Traffic and transport

12.1. Introduction

This chapter deals with mitigation measures for impacts of traffic and transportation in relation to the Tafila wind farm. The main transportation, social and environmental effects will be due to the heavy goods vehicles (HGV) which will enter and exit the site during the construction and decommissioning phases of the wind farm.

Once the wind farm is operational, it is considered that the amount of traffic associated with the farm will be minimal and HGV will appear on site only in exceptional cases. During this time, only occasional maintenance and repairs will generate a small amount of traffic.

12.2. Mitigation and monitoring measures

The following section establishes the measures that will be employed in order to avoid or mitigate various traffic-related effects.

Table 12-1: Mitigation and monitoring measures for impacts on traffic

Effect	Mitigation measure [MM]	Monitoring measure
Hindrance to drivers of other motor vehicles	• Set up of traffic management plan for transporting exceptional loads; [MM73] • Transportation in small convoys; [MM74] • Timed delivery to avoid peak traffic movements. [MM75]	• Regular auditing of mitigation measures; • Responsibilities lie within the tasks of the contractor and the Sponsor Project Manager.
Traffic safety	• Set speed limit to 20 km/h on the wind farm site and [MM62] • Reduce speed limit at sharp bends below 20 km/h [MM76]	• Regular auditing of mitigation measures; • Responsibilities lie within the tasks of the contractor and the Sponsor Project Manager.
Dust and dirt	• Construct last meters of project site roads as asphalted road to minimize dirt and dust on wheels by entering public roads. [MM77]	• No monitoring measures proposed. Enforcement lies within the responsibility of JWPC.

13. Socio economics

13.1. Introduction

This section considers the socio-economic effects of the proposed wind farm at Tafila. The proposed wind farm could have important positive and potentially some negative impacts on the local community and on the economy of the surrounding area.

Socio-economic impacts are considered to focus on the quality of life of local residents and both local and regional business activity. Wider economic effects may well be felt nationally by the Jordan renewable energy industry.

13.2. Mitigation and monitoring measures

Table 13-1: Mitigation and monitoring measures for impacts on the socio economics

Effect	Mitigation measure [MM]	Monitoring measures
Employment	• Employment of qualified local people in recruitment for skilled and non-skilled construction and operation staff; [MM78] • Acquire all possible supplies, such as food and beverages and office supplies, from local stores during all project phases; [MM79] • Use local vehicle maintenance workshops and oil change stations. [MM80] • Providing shadow flickering maps on boards, erected around the wind farm. Based on these maps tribes can choose the best locations to reside periodically [MM81]	• Employment of qualified workers lies within the responsibility of contractor

Further to the above listed supporting measures of the local society, JWPC conducts a program of social improvements. The social programs are the following:

13.2.1. Partnership with the Royal Society for the Conservation of Nature (RSCN)

The RSCN is Jordan's foremost environment and sustainability organization, and operates the Dana Nature Reserve, located approximately 5 km southwest of the project area. RSCN's focus on environmental issues and their presence at the nearby Dana Reserve makes RSCN a natural choice for partnership with the Tafila Project.

The partnership with RSCN would bring expertise from the foremost Jordanian NGO into quantifying and documenting the presence of the project on the local and regional environment, particularly the bird population. Findings from RSCN could be used to predict and analyze the impact of future wind farms on the Jordan environment. RSCN could also expand its environmental data collection for the Tafila area.

This partnership would see services and support provided by RSCN, and financial contributions and other inputs from the project.

13.2.2. Bird Monitoring by Dana staff

During the construction and operation phase of the wind farm, local staff from the Dana reserve will be responsible for bird monitoring throughout the wind farm area.

13.2.3. Environmental Education Training at the Visitor Center

Following discussions with the Dana Reserve administration, JWPC will provide funds for the center to implement a unit for training the visiting school children on the environmental issues. This effort will be linked to be managed in conjunction with the Wind Farm Visitor Centre (described in chapter 13.2.3 below) so that the center can organize supervised visits to the Wind Farm.

13.2.4. Visitor Information Center

The project is planning to locate a visitor center in Dana, which will also serve as a classroom area for local students visiting the project site. The visitor center will be staffed by JWPC and possibly RSCN representatives who will provide information on the features of the project, as well as the process of wind energy generation, and the local environment of the project area.

13.2.5. Local schools, university and municipality improvements

Improvements to local town infrastructure, in the form of high efficiency heating / cooling / lighting, solar rooftop installations, communication equipment, and other possible improvements are planned to be provided by the project sponsor. Computers and / or blackboards will be sponsored for the schools in the vicinity. Such improvements will be discussed in detail with the local municipalities.

The technical university of Tafila will be sponsored.

13.2.6. Land Lease Revenues

Local land owners have the advantage of participating in the economic presence of the project due to their annual revenues from the land lease agreements with JWPC.