Dumat Al Jandal Wind Energy Park

Saudi Aramco

Environmental & Social Impact Assessment

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Dumat Al Jandal Wind Energy Park

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ES1. Executive Summary

ES1. Introduction

In April 2016 the Kingdom of Saudi Arabia announced Vision 2030, which defines the long-term social and economic goals of the country. As part of the National Transformation Plan developed to meet the goals of Vision 2030, the Ministry of Energy, Industry and Mineral Resources (MEIM) launched the National Renewable Energy Program (NREP) which seeks to implement 9.5 GW of renewable power by 2023.

A Renewable Energy Project Development Office (REPDO) was established under the jurisdiction of the MEIM to oversee the implementation of the national program. The REPDO is comprised of staff from the MEIM, Saudi Aramco, the Saudi Electricity Company (SEC) and King Abdullah City for Atomic and Renewable Energy (KACARE). MEIM has appointed a team of advisers to provide legal, financial and technical consultancy services. Japanese bank Sumitomo Mitsui Banking Corporation (SMBC) has been appointed as financial adviser, UK-based law firm DLA Piper has been appointed as legal advisor and Germany's Fichtner has been appointed as engineering and technical advisor.

The first round of renewable energy projects has recently been launched, and these renewable schemes will be developed under the independent power producer (IPP) model. A special purpose vehicle will be formed for each scheme and will be 100 per cent owned by the successful bidder. Saudi Aramco is supporting this first round of projects by providing land and conducting feasibility and pre-development studies. The Dumat Al Jandal Wind Energy Park is included within this first round of projects.

The arrangements for the financing of renewable energy developments in the Kingdom of Saudi Arabia are currently under review, but the developments may be funded by third party financing from the international markets. As a result, the lending banks require an ESIA to be undertaken in accordance with international environmental development standards, particularly those of the World Bank, IFC and the 'Equator Principles'.

Recent advancements in wind turbine technology suggest that increasing the design 'tip height' of the wind turbines from 175m to 225m will give investors in the Park further flexibility to implement a more optimal technology solution and deliver lower cost of electricity. This revision of the ESIA considers a design change in turbine height. A 155 m hub height and a 140 m rotor diameter (i.e. 155 + 70 = 225 m) has been assumed. All other aspects of the design remain unchanged (e.g. turbine number, configuration etc.).

This Environmental and Social Impact Assessment (ESIA) prepared for the Dumat Al Jandal Wind Energy Park has been prepared in accordance with the lending requirements of these financial institutions and therefore demonstrates compliance with these principles.

ES2. Project Description

The development site is located on a raised, flat plateau at an altitude of between 700m to 800m above sea level. The majority of the desert plateau is characterized by bare rock. Small seasonally inundated patches of vegetative growth occur within the shallow flow paths (i.e. wadis) which convey pluvial run-off during periods of rainfall. There is no single well defined flow path across the plateau within the developable area of the Park. The majority of flow paths on the plateau are defined as minor and the only major wadis are located on the edge of the plateau, particularly to the south and east. The flows draining from the plateau form multiple small scale localized wadi channels around the perimeter of the Park. These drain into more clearly defined major wadi channels off-site.

The surrounding landscape to the north, east and south ranges between 100m to 200m below the height of the development site. Due to this sharp drop-off in height, the edges of the plateau are typically characterized by large boulder scree slopes at 45º angle, or steeper, with little to no vegetation. The plateau gives way to sheer cliff edges along some sections of the northern edge where a vast basin lies below the site. This basin lies within the developable area of the Park and has been accounted for in the preliminary design.

The location has been chosen as the optimal location for a Wind Energy Park, as a result of detailed site analysis and survey undertaken by Saudi Aramco against four main selection criteria;

- Potential to offset hydrocarbon use;
- Availability of land;
- Regional development; and,
- Wind resource.

The Park will utilize wind technology on an area of approximately 71km^2 and is expected to have a total installed capacity of approximately 400 Mega-Watt (MW). The Park will be implemented during a single phase.

The Park consists of a wind power plant, including up to 130 wind turbine generators (WTGs) with a maximum height of up to 225 meters (m), and an associated grid interconnection, including a medium voltage/high voltage (MV/HV) sub-station and HV overhead lines connecting the sub-station to the electrical transmission system owned by the Saudi Electricity Company (SEC).

When fully implemented the Park is expected to generate approximately 1450 Giga-Watt hours (GWh) per annum, displacing 2,700 Thousand Barrels of Oil Equivalent (MBOE) of hydrocarbons per annum and 1,000 Thousand tons (Mt) of CO_2 per annum, and create 600 person years of construction work and 80 operations and maintenance jobs.

Construction of the Park was expected to start in Q2 2018 and will take approximately 20 months.

ES3. Consideration of Alternatives

The proposals for the Park have been developed following the consideration of a range of project and design alternatives including:

- “Do Nothing” option;
- Location alternatives; and,
- Configuration and alternative production options;

The final layout and specifications of the Park are yet to be determined and will be confirmed by the IPP during the next phase of development following further modelling and consideration of environmental and social impacts and ongoing stakeholder consultation.

ES4. Summary of Significant Impacts

The ESIA for the Park has been undertaken according to General Administration for Meteorology and Environment (GAME), World Bank Group and IFC guidance. It has considered all potential impacts of the construction, commissioning, operation and decommissioning of the Park on the environment, employees, and local community. Furthermore, it has also considered these effects in combination with each other and with other development in the area. The Environmental Assessment includes an Environmental Management and Monitoring Plan (EMMP), and an outline Environmental Emergency Response Plan (EERP). These plans detail the measures identified in this phase for mitigation of any impacts, and provide guidance for emergency preparedness in the event of an accident. These plans are considered as “live” documents, which are updated with any further recommendations identified in future phases. The EMMP will be supported by a series of management plans which will be developed throughout the lifetime of the Park and updated accordingly. A description of some of these plans (referred to as ‘EMPs’ in the following sections) is outlined in the EMMP (ESIA, Appendix A). The results of the impact assessment are summarized below.

Potential impacts predicted as being of medium to high significance were assessed against appropriate mitigation measures to predict the residual impact significance. Potential impacts of lower significance were also identified, and although specific mitigation measures are not required for these aspects, a series of recommendations which are considered as good management practices are identified.

ES 4.1Meteorology, Climate and Air Quality

Key impacts related to Meteorology and Air Quality expected to occur as a result of the introduction of the Park will be associated with both the increased emissions of Green House Gases (GHGs) during the construction and decommissioning of the Park, and dust generated by construction and decommissioning traffic.

The assessment of GHG emissions from the Park show that although CO_2 emissions are likely, particularly during the construction stage, the overall impact of the scheme is considered to be a 'net benefit' based on the displacement of emissions of CO_2 from the use of fuel oil as an alternative for power generation, and that it will contribute to the Kingdom of Saudi Arabia's INDC target to annually abate up to 130 $MtCO_2e$ by 2030.

Therefore, it is concluded that the Dumat Al Jandal Wind Energy Park is acceptable from an air quality and greenhouse gas emissions basis.

ES 4.2 Soils and Geology

The key impacts expected to occur as a result of the Park upon local soils and geology, relate to the contamination of soil through uncontrolled discharges such as leaks and spills, and the loss of soil resource due to increased wind blow during the construction and decommissioning phases of the Park.

The Park will be constructed in accordance with the guidance laid out in the GAME rules and regulations for implementation, and the relevant IFC EHS guidelines and Performance Standards. These include recommendations related to the storage of materials in double bunded areas and on hard surfacing, and the use of containment measures such as oil interceptors and spill kits.

Due to the intention to follow these recommendations, no negative impacts of moderate or high significance are anticipated.

ES 4.3 Hydrology and Hydrogeology

The key impacts associated with hydrology and hydrogeology expected to occur as a result of the introduction of the Park, relate to the interaction of the turbines and infrastructure, with the minor wadi flow paths found across the plateau of the development site. Although these are not considered to be key flow routes, they are subject to pluvial flooding during periods of high rainfall.

A detailed flood risk assessment was carried out during the pre-feasibility stage of the development. This study included a full modelling and analysis of the flow paths within the development site, and identified areas of potential water storage during high rainfall events. The study made recommendations intended to reduce the impact of the flow paths upon the infrastructure of the Park, and therefore consequentially, reduce the impact of the Park upon the flow paths. The recommendations made within this study will be carried through to the detailed design of the Park and include suggestions for the relocation of turbines out with flow paths and known sink holes.

Other impacts relate to the contamination of groundwater due to leaks and spills during construction and decommissioning of the Park. All on site operations will be carried out in accordance with the requirements of the relevant GAME standards and IFC EHS guidelines and Performance Standards, these include requirements such as the use of oil interceptors and spill kits, and the proper storage and management of potential contaminants.

Following the integration of the recommendations made in the flood risk study and report, and the intent to construct the Park according to the relevant standards, there are no anticipated impacts upon minor wadi flow paths or groundwater within the development site.

ES 4.4 Noise and Vibration

It is anticipated that impacts related to noise and vibration would be experienced across all phases of the development.

The key impacts experienced during construction and decommissioning of the Park relate to the adverse noise arising from the use of generators at construction camps, consideration will be given to the location of generators and their positioning as far as reasonably practicable from sensitive receptors, (including those working and living within the construction camp) during the construction phase.

During operation of the Park, it is anticipated that an adverse increase in noise levels may be experienced at the closest residential receptors to the Park boundary, primarily those scattered farms which are found adjacent to the south western boundary of the development site. The assessment has been based on a precautionary approach and modelled using a turbine with an average noise output. The turbine specification is yet to be confirmed, although preference will be given to turbine models which generate reduced noise emissions.

Despite the intention to utilize turbines with lower sound output levels, further noise modelling will be carried out by the IPP during the next phase of development in order to understand impacts in detail and make appropriate mitigation recommendations.

ES 4.5 Landscape and Visual

Landscape and visual impacts are considered to be the same across all phases of the development.

The key landscape and visual impacts expected to arise as a result of the introduction of the Park would be experienced at receptors within the local area. Particularly those local farms within close proximity to the boundary of the development site who will experience a view of the Park above the horizon. Although there would be a change to these views, the residential properties at the farms, are screened by boundaries consisting of tall trees which would reduce the magnitude of change significantly.

There would also be a significant change to views experienced at the Marid Castle, however, this would be intermittent depending on climatic and weather conditions

Due to the long range (approximately 10km) to the nearest major settlement, and the scattered nature of views within closer proximity, it is not anticipated that any significant detrimental landscape and visual impacts would be experienced as a result of the introduction of the Park.

ES 4.6 Terrestrial Biodiversity

The terrestrial biodiversity baseline for the Dumat al Jandal Wind Energy Park was determined through desk-top review of available sources and literature, and field surveys undertaken between November 2016 and May 2017. Baseline field surveys comprised a Phase 1 habitat survey, vegetative community survey, transect surveys for mammals, reptiles and invertebrates, faunal surveys using Bushnell Trophy Cam trail cameras and automated bat activity surveys using Anabat Express devices. A total of 1,646 hours of recording time was completed using the trail cameras, and 1,420 hours of recording time was completed using the Anabat Express devices.

The development site is predominantly characterized by an extensive exposed desert plateau punctuated by various shallow flow routes which lead to lower lying areas and basins in the surrounding landscape. The dominant bare, rocky ground habitat only supports very sparse and sporadic coverage of *Acacia* ssp., and rarely *Anastatica hirochuntica*. These species occur in small depressions in the otherwise bare landscape where sand and aeolian sediments have accumulated allowing the sparse hardy plant communities to settle. There is no single well defined flow path across the plateau within the developable area of the Park. The majority of flow paths on the plateau are defined as minor and the only major wadis are located on the edge of the plateau, particularly to the south and east. The flows draining from the plateau form multiple small scale localized wadis around the perimeter of the Park. These drain into more clearly defined major wadi channels off-site. During the baseline surveys no endemic or rare species of flora or invertebrates were recorded.

A total of six mammal species have been recorded within the developable area of the Park (i.e. red fox *Vulpes vulpes*, probable Sundevall's jird *Meriones crassus*, desert hedgehog *Paraechinus aethiopicus*, lesser Egyptian jerboa *Jaculus jaculus*, golden spiny mouse *Acomys russatus* and domestic dromedary camel *Camelus dromedarius*). The conservation status of these species is listed as Least Concern by the International Union for the Conservation of Nature (IUCN) Redlist.

Seven species of lizard were recorded during the baseline surveys (i.e. Egyptian spiny tailed lizard *Uromastyx aegyptia,* small-spotted lizard *Mesalina guttulata,* toad headed agama *Phrynocephalus maculatus,* Nidua fringe-fingered lizard *Acanthodactylus scutellatus*, Saudi fringe-fingered lizard *Acanthodactylus gongrorhynchatus,* snake tailed fringe toed lizard *Acanthodactylus opheodurus* and an unidentified fringe toed lizard *Acanthodactylus* spp. Most species are not listed on the IUCN Redlist or the conservation status is listed as Least Concern. Only the Egyptian spiny tailed lizard is listed as Vulnerable by the IUCN as there has been a suspected population decline of over 30% over the past 15 years (3 generations) and this is expected to continue into the future.

A total of 646 passes from at least four species of bat were recorded, with two species identified with a high level of confidence. The overall activity rate (2.6 Bats/hour; 30.8 Bats/night) was relatively low as was the species diversity. The species recorded comprised Kuhl's pipistrelle *Pipistrellus kuhlii*, desert long-eared bat *Otonycteris hemprichii*, Sind bat *Eptesicus nasutus* and/or Botta's serotine *Eptesicus bottae*, and a *Molossidae* species of bat, most likely to be Egyptian free-tailed bat *Tadarida aegyptiaca*.

A primary concern during the development of a wind energy power plant is the risk of mortality or injury to birds colliding with the wind turbine infrastructure, particularly the rotor blades. Migratory, breeding and wintering ornithological surveys have been completed at the proposed Dumat Wind Energy Park. A combination of Vantage Point (VP) survey effort across two migration seasons, spring and autumn 2017, and constant effort surveys were undertaken to achieve robust coverage of the development site. Upon completion of the surveys detailed data analysis, including Collision Risk Modelling, has been undertaken.

Over 450 hours of VP survey were undertaken during migration periods across nine separate VP locations to provide sufficient coverage of the proposed turbine layout. A total of 6160 target species individuals of 23 species were recorded during the survey which generated a total of 759 separate flight lines. A further three target species were observed through constant effort surveys observations.

Collision risk modelling has been undertaken. The most abundant target species recorded was steppe buzzard (5271 individuals, 209 flights), which is reflected within the Collision Risk Modelling as the most 'at risk' species. A worst-case scenario model predicted 63.08 collisions each year at the development site, with a more refined model predicting 38.88 collisions per year. More than one hundred individuals were recorded of the following four target species (in addition to steppe buzzard): European honey buzzard (187 individuals recorded and 33 flight lines); black kite (132 individuals and 59 flight lines); marsh harrier (127 individuals and 92 flight lines); and pallid harrier (113 individuals and 109 flight lines). Steppe buzzard (see above), European honey buzzard (3.67 collisions per year), black kite (1.48 collisions per year) and steppe eagle (1.06 collisions per year) make up the four species for which worst-case scenario modelling predicted more than a single collision each year. For the remaining target species fewer than one collision per year was predicted.

Three of the target species recorded within the development site are listed as 'Endangered' by the IUCN (2017); Egyptian vulture (six individuals), saker falcon (one individual) and steppe eagle (75 individuals, including constant effort survey records). Refined collision risk modelling predicted 0.77 collisions per year for steppe eagle, which is equivalent to a collision every 1.3 years. For Egyptian vulture and saker 0.10 and 0.01 collisions per year were predicted.

At this stage of the assessment, no significant residual impacts of moderate or high significance on ecological receptors are predicted during the construction, operation and decommissioning phases of the Park. The majority of receptors are sensitive at the site or local level only.

The developable area of the Park currently provides regulating, cultural and provisioning services. The construction and operation of the Park are not predicted to significantly impact on the regulating or provisioning ecosystem services. Construction impacts of moderate significance are predicted on cultural services. With mitigation these can be reduced to low.

ES 4.7 Archaeology and Cultural Heritage

Although there are no known cultural heritage assets within the vicinity of the Park, construction may result in the uncovering of previously undiscovered assets. A chance find procedure is a requirement of ICF Performance

Standard 8 and will be implemented during the construction and decommissioning phases in order to ensure that this is properly managed.

The development of the Dumat Al Jandal Wind Energy Park is not expected to impact upon tangible cultural heritage assets within the development site or the surrounding area. The nearest assets identified by the Saudi Commission for Tourism and Antiquities are located approximately 1km to the south of the nearest turbine.

ES 4.8 Traffic and Transport Infrastructure

The key impacts related to traffic and transport infrastructure expected to occur are associated with the increase in traffic volume expected to occur as a result of the construction of the Park.

There will be a marked increase in traffic on key routes in the vicinity of the development site during the construction phase of the Park, furthermore, there will be an introduction of abnormal vehicles required to transport the turbine components from their point of arrival in the Kingdom of Saudi Arabia, to their point of installation at the development site.

The routes to be used are as yet unconfirmed, and will be finalized by the IPP as part of the traffic management plan contained within the Environmental Monitoring and Management Plan during the next stage of development. Consideration will be given to the minimization of disruption caused by the introduction of additional vehicle traffic along key routes within the Kingdom of Saudi Arabia.

Additionally, the construction of the Park will increase the risk of accidents associated with vehicular traffic. This will be managed through the preparation of a traffic management plan which will be included within the Environmental Management and Monitoring Plan.

All transportation will be carried out as per the requirements of the relevant Ministry of Transport standards and permits, and the relevant GAME and IFC guidelines and standards.

ES 4.9 Socio-Economic Aspects

Impacts upon socio economic receptors expected to arise as a result of the construction, operation and decommissioning of the Park are expected to be both positive and negative. Positive impacts include job creation, economic growth and education opportunities for local communities. Negative impacts include reduced access to land, increased pressure on services and impacts upon existing livelihoods.

The Environmental Management and Monitoring Plan includes recommendations to enhance the potential benefits of the Park and minimize the negative impacts, therefore, the positive socio economic benefits outweigh the negative impacts.

Implementation will be carried out with regard to the relevant IFC Guidelines and standards in order to ensure the fair treatment of both vulnerable individuals and communities during the construction, operation and decommissioning phases of the Park.

It is anticipated that the introduction of the Park into the socio economic environment would result in a net positive impact upon local communities and receptors.

ES 4.10 Utilities Infrastructure and Usage

The key impacts upon utilities infrastructure and usage expected to arise as a result of the Park are both positive and negative.

Positive impacts expected to arise relate to the increase in headroom in the local energy supply due to the additional power generated by the operation of the Park.

Negative impacts experienced during the construction and decommissioning phases will be temporary and primarily relate to the increased burden on local utilities required to supply the construction workforce, and supply the necessary resources for construction of the Park.

The negative impacts associated with an increase in pressure on local utilities would be outweighed by the net increase in power generation capacity that the Park would yield, and therefore no significant negative impacts are predicted.

ES 4.11 Waste Management

Waste will be generated during construction and decommissioning of the park, this will include ‘normal’ wastes such as construction waste, oils, paints and lubricants and ‘non normal’ wastes such as those associated with the maintenance, replacement and repair of wind turbines and their components.

Normal wastes will be stored and handled in accordance with the relevant game and IFC standards. The wind turbine manufacturer will reclaim all non-normal wastes for refurbishment and reuse.

The current capacity of local waste management facilities is not known at present, and will be followed up during ongoing stakeholder consultation, to be carried out by the IPP in the next phase of development. Despite this, the quantity of waste expected to be generated is such, that there are not expected to be any significant impacts upon waste management infrastructure associated with the park.

ES 4.12 Health and Safety Aspects

There are a number of potential impacts upon the health and safety of both the workforce and the local community expected to arise as a result of the introduction of the Park.

Even following the integration of mitigation measures into the planned development of the Park, there are a number of residual risks of moderate significance which are expected to occur. These risks recognize the unique hazards associated with the development of wind energy power plants and have considered that this will be one of the first developments of its type within the Kingdom of Saudi Arabia. As such, the construction workforce within the Kingdom will not be skilled in the assembly, installation and ongoing maintenance of wind energy power plants.

It is recommended that the IPP develops a Permit to Work system for the development and operation of the Park. A Permit to Work system is a management system that is used to ensure that work is done safely and efficiently and establishes procedures to request, review, authorize, document and most importantly, deconflict tasks to be carried out by frontline workers. This is particularly important for high risk construction and maintenance operations (e.g. working at height, heavy lifting, confined spaces working, remote working).

The Permit to Work system must account for the unique environment of the Kingdom of Saudi Arabia, including extreme temperatures and humidity, in-Kingdom workforce attitudes and behaviors towards safety and the preservation of life, and religious practices (e.g. fasting during the month of Ramadan).

In addition to the health screening of workers for communicable disease, it is recommended that workers who perform high risk activities (i.e. working at height, confined spaces working) and operators of specialist equipment (e.g. heavy lifting equipment, vehicles carrying exceptional loads) are subject to regular medical and fitness checks.

ES 4.13 Sustainable Development

The sustainable development assessment concluded that there would be some negative impacts associated with the construction, operation and decommissioning of Park, particularly related to noise during construction, operation and decommissioning. However, the Park will be constructed and decommissioned in line with the relevant IFC and GAME guidelines and standards, and this would significantly mitigate the long term effects of these impacts.

The positive impacts associated not only with the power generated and fed directly into the grid by the Park itself, but also the precedent which is set through the introduction of renewable energy into the power generation portfolio of the Kingdom of Saudi Arabia, would outweigh the negative impacts, particularly in the context of the recommended mitigation measures.

It is therefore concluded that the Park represents a significant positive contribution to the sustainable future of the Kingdom of Saudi Arabia as a whole.

ES 4.14 Cumulative Impact Assessment

The cumulative impact assessment concluded that although the Park would represent additional infrastructure in an area which is not significantly developed, the contribution it would make to the majority of impact trends experienced in the area, is minor and as such the Park does not represent a significant contribution as a whole, to the degradation of the local environment.

ES5. Conclusions

The Dumat al Jandal Wind Energy Park will contribute towards a more balanced energy mix in the Kingdom of Saudi Arabia; and will contribute towards displacing 2,700 Thousand Barrels of Oil Equivalent (MBOE) of hydrocarbons per annum and 1,000 Thousand tons (Mt) of CO_2 per annum from the Saudi Electricity Company power plant in Al Jouf.

This ESIA document presents the systematic assessment of potential construction, operation and decommissioning impacts. Based on the preliminary engineering design of the Park, and the stakeholder engagement and consultation that has been undertaken to date, the majority of the residual impacts are predicted to be of low to negligible significance, following the implementation of mitigation and good international industry practice.

Notwithstanding, there are some notable residual impacts of high and moderate significance for the following environmental and social aspects: Noise and Vibration, Landscape and Visual Impact, Traffic and Transportation, Waste Management and Health and Safety.

Mitigation measures have been suggested to reduce the significance of these residual impacts as far as reasonably practicable, these recommendations primarily relate to the preparation of management and monitoring plans and the alteration of the final design in the light of further studies to be undertaken by the IPP during the next phase of development.

The findings of the ESIA should be reviewed following more extensive stakeholder consultation, and once the design of the new power plant has been further developed. If required, an Addendum to this ESIA will be prepared by the IPP, in consultation with project stakeholders.

1. Introduction

1.1 Overview

In April 2016 the Kingdom of Saudi Arabia announced Vision 2030[1], which defines the long-term social and economic goals of the country. As part of the National Transformation Plan developed to meet the goals of Vision 2030, the Ministry of Energy, Industry and Mineral Resources (MEIM) launched the National Renewable Energy Program (NREP) which seeks to implement 9.5 GW of renewable power by 2023.

A Renewable Energy Project Development Office (REPDO) was established under the jurisdiction of the MEIM to oversee the implementation of the national program. The REPDO is comprised of staff from the MEIM, Saudi Aramco, the Saudi Electricity Company (SEC) and King Abdullah City for Atomic and Renewable Energy (KACARE). MEIM has appointed a team of advisers to provide legal, financial and technical consultancy services. Japanese bank Sumitomo Mitsui Banking Corporation (SMBC) has been appointed as financial adviser, UK-based law firm DLA Piper has been appointed as legal advisor and Germany's Fichtner has been appointed as engineering and technical advisor.

The first renewable energy projects have recently been launched, and these renewable schemes will be developed under the independent power producer (IPP) model. A special purpose vehicle will be formed for each scheme and will be 100 per cent owned by the successful bidder. Saudi Aramco is supporting these projects by providing land and conducting feasibility and pre-development studies. The Dumat Al Jandal Wind Energy Park is included within the first round of projects.

The arrangements for the financing of renewable energy developments in the Kingdom of Saudi Arabia are currently under review, but the developments may be funded by third party financing from the international markets. As a result, the lending banks require an ESIA to be undertaken in accordance with international environmental development standards, particularly those of the World Bank, IFC and the 'Equator Principles'. This Environmental and Social Impact Assessment (ESIA) prepared for the Dumat Al Jandal Wind Energy Park has been prepared in accordance with the lending requirements of these financial institutions and therefore demonstrates compliance with these principles.

Further to the submission of the original Environmental and Social Impact Assessment for Dumat al Jandal, the specification of the turbines has been amended. Recent advancements in wind turbine technology suggest that increasing the design 'tip height' of the wind turbines from 175m to 225m will give investors in the Park further flexibility to implement a more optimal technology solution and deliver lower cost of electricity. This revision of the ESIA considers the design change in turbine height. A 155 m hub height and a 140 m rotor diameter (i.e. 155 + 70 = 225 m) has been assumed. All other aspects of the design remain unchanged (e.g. turbine number, configuration etc.).

1.2 Project Understanding

The Dumat Al Jandal Wind Energy Park (the Park) will use wind technology on an area of approximately 71 km^2, and is expected to have a total installed capacity of approximately 400 Mega-Watt (MW). The Park will be implemented in a single phase.

The Park consists of a wind power plant, including up to 130 wind turbine generators (WTGs) with a maximum height of up to 225 meters (m), and an associated grid interconnection, including a medium voltage/high voltage (MV/HV) sub-station and HV overhead lines connecting the sub-station to the electrical transmission system owned by the Saudi Electricity Company (SEC).

When fully implemented the Park is expected to generate approximately 1450 Giga-Watt hours (GWh) per annum, displacing 2,700 Thousand Barrels of Oil Equivalent (MBOE) of hydrocarbons per annum and 1,000 Thousand tons (Mt) of CO_2 per annum, and create 600 person years of construction work and 80 operations and maintenance jobs.

[1] http://vision2030.gov.sa

Construction of the Park was expected to start in Q2 2018 and will take approximately 20 months.

Figure 1.1 shows the site location.

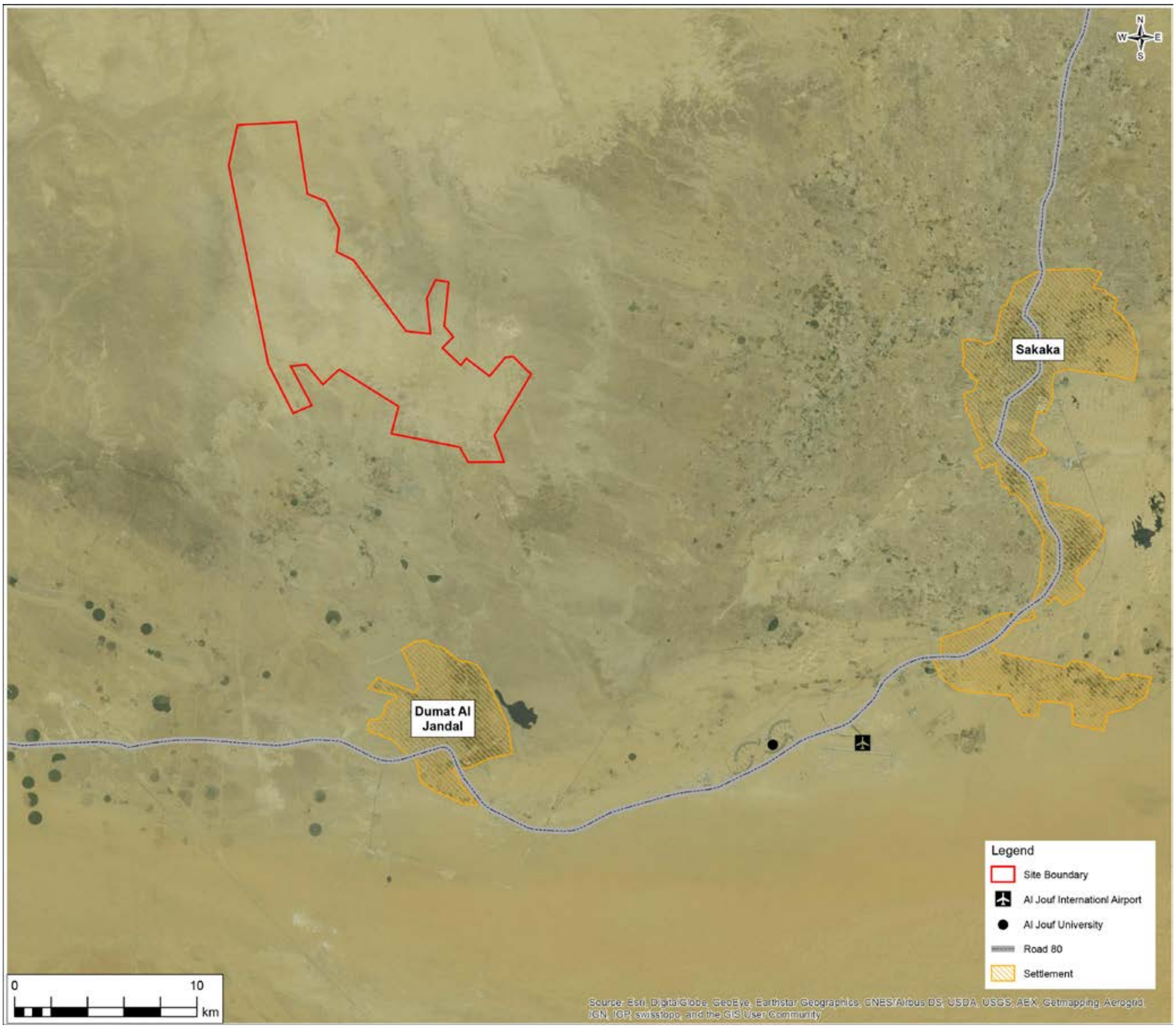


Figure 1.1: Site Location

1.3 The Dumat Al Jandal Wind Energy Park Development Site

The Park is located to the north of Dumat Al Jandal, Al Jouf Province, northern Saudi Arabia. This location has been chosen as the optimal location for a Wind Energy Park, as a result of detailed analysis and survey by Saudi Aramco against four main selection criteria;

- Wind resource;
- Availability of land;
- Potential to offset hydrocarbon use; and,
- Regional development.

1.4 Objectives of the ESIA

The objective of this Environmental and Social Impact Assessment is to identify significant adverse and beneficial environmental and social impacts attributable to the development of the Park, and to propose mitigation and remedial measures to reduce adverse impacts to acceptable levels.

In accordance with World Bank Operational Policy 4.01 the ESIA takes into account the natural environment, human health and safety, social aspects, and transboundary and global environmental aspects in a fully integrated assessment and reporting process. This includes the capacity of existing institutions and infrastructure to manage the predicted environmental and social effects.

The ESIA is also intended to provide the relevant regulators, lenders and other stakeholders with sufficient information, to allow them to make informed decisions regarding the proposed Park.

1.5 ESIA Screening

An integral part of the development of renewable energy power plants is to assess and mitigate the potential environmental and social impacts arising from their construction, operation and decommissioning. The purpose of ESIA Screening is to determine the level of environmental assessment and reporting likely to be required to ensure compliance with regulatory requirements. The Phase 1: Environmental Assessment Legislation and Guidelines Review (Jacobs, 2017a) recommends screening criteria for renewable energy development projects in the Kingdom of Saudi Arabia, aligned to both National and International requirements. These criteria have been used to determine the ESIA Screening category for the Park.

1.5.1 ESIA Screening Outcome

The General Environmental Regulations and Rules for Implementation (GERRI) were implemented in 2001,through Royal Decree No. M/34. These regulations set out the requirements for environmental impact assessment within the Kingdom of Saudi Arabia. The GERRI set out three categories for developments, with category one representing the lowest level of environmental impact, and three representing the highest.

Following a comparative review, the Phase 1 report concluded that all utility scale (defined as those with multi mega-watt capacity) renewable energy power plant developments in the Kingdom of Saudi Arabia should be classified as GERRI Category 3 developments, (equivalent to World Bank, IFC and EP Category A), on the basis that they have the potential to cause permanent or irreversible damage to the environment during construction or operation. Therefore, in line with the Phase 1 report, the Dumat Al Jandal Wind Energy Park is considered to be a GERRI Category 3 development. For the purposes of this report, utility scale renewable energy power plant developments are defined as those with a multi-megawatt capacity.

It is possible to reduce the initial classification of a project if further assessment determines that the development has limited potential for adverse environmental and social risks and/or impacts are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures.

As reported in the Dumat Al Jandal Wind Energy Park Phase 2 Fatal Flaw Analysis and Baseline Survey report (Jacobs ZATE, 2017b), the fatal flaw analysis identified one aspect to be prioritized for further investigation and assessment; this is the proximity of the turbines to Al Jouf International Airport and the potential for radar interference. It was recommended that a radar impact assessment should be undertaken to determine if the development has the potential to impact radar. This impact assessment has now been undertaken (Appendix K).

If significant impacts on radar are identified, this has the potential to affect the viability of the development site for wind power generation. Further investigation was recommended as part of the ESIA. A precautionary approach was therefore taken and the Park was categorized as a **GERRI Category 3 development.**

1.6 Scope of the ESIA

Environmental scoping is a critical first step in the preparation of an ESIA. It is the process of determining the content and extent of matters to be covered in the environmental information to be submitted to a competent authority, in this case the MEIM.

The process describes the key likely environmental aspects and effects of the Park, and the proposed methods for survey, evaluation and analysis, for the impact assessment. It also ensures that the project proponent is aware of the likely environmental issues and has an understanding of the expected implications. The early identification of key environmental effects of a development also maximizes the opportunity to avoid potential impacts through influencing the engineering design. The avoidance of impact by modifying the engineering design can help to manage the risk of potentially expensive mitigation at a later stage.

The scope of the environmental assessment and subsequent ESIA is aligned with the preliminary development design and reported in the Dumat Al Jandal Wind Energy Park Environmental and Social Impact Assessment Terms of Reference (Jacobs Zate, 2017c).

The ESIA terms of reference identified the following primary issues which require detailed study as part of the ESIA:

- Air Quality.
- Archaeology and Cultural Heritage.
- Community Health and Safety.
- Hydrology and Hydrogeology.
- Indigenous Peoples.
- Landscape and Visual.
- Noise and Vibration.
- Socio-Economics.
- Soils and Geology.
- Terrestrial Biodiversity.
- Traffic and Transportation.

1.6.1 Limitations

Saudi Aramco has developed a preliminary design to facilitate pre-development activities, including environmental permitting. The preliminary design includes the layout of the wind turbines and ancillary infrastructure within the development site, and the proposed connection to an existing overhead power line and transmission to the nearest Saudi Electricity Company (SEC) sub-station. The preliminary design does not outline the intended methods to be used during the construction phases of the development, including the requirements for material laydown areas and accommodations, supply and transportation of construction materials and equipment, and the transportation of wind turbine generators and towers to site. These aspects will be considered and developed further by the Independent Power Producer (IPP) during the next phases of development.

The scope of the environmental assessment is therefore aligned with the preliminary development design, and the ESIA will be developed as far as possible in terms of the overall development scope to support the in-Kingdom environmental approvals process. For the development site, the assessment of impact will be completed using baseline data and a robust set of design criteria. For aspects of the development which remain uncertain, or are beyond the boundary of the development site and for which there is no design, the precautionary approach will be adopted. This approach will comprise a precautionary assessment of impact against a set of design assumptions to be agreed with the project proponent, using data from desk-based review only.

This approach is assessed as sufficient to secure the in-Kingdom environmental permit, and establish a benchmark against which the ESIA can be reviewed. An addendum to the ESIA will be prepared by the IPP during the next phases of development, to confirm the impact assessment for the finalized design, including an update to the precautionary approach.

1.6.2 Stakeholder Consultation

International lending standards specify the requirement for public consultation and disclosure and engagement with Affected Communities. A Stakeholder Engagement Plan (SEP) has been prepared which establishes a development specific framework for structured and culturally appropriate consultation, in a manner which enables the Affected Communities to express their views on the development risks, impacts and mitigation measures. In particular, the plan communicates how and when consultation will be undertaken and identifies the process for the disclosure of information, consultation and participation, grievance mechanism and ongoing reporting to the Affected Communities (IFC, 2012a).

The plan covers the life-cycle of the development, and stakeholder consultation with Government Ministries and bodies was approved by the MEIM in February 2017. A stakeholder engagement meeting was held in Riyadh with Government Ministries on the 25th May 2017 during which the details of the project were disclosed, and the scope of the ESIA was discussed. The list of identified stakeholders for the project, and their attendance at the workshop on 25th May are listed in Table 1-1. It is important to note that all stakeholders are committed to Vision 2030 and the achievement of the 9.5 GW of renewable energy by 2023, and no objections to the Dumat Al Jandal Wind Energy Park were raised.

Table 1-1: Dumat Al Jandal Wind Energy Park Stakeholder Consultation

Stakeholder	Attended
Ministry of Transportation	X
Public Investment Fund (PIF)	✓
Ministry of Defense	✓
Ministry of Interior	✓
Ministry of Energy, Industry and Mineral Resources (MEIM)	✓
General Authority for Civil Aviation (GACA)	✓
Saudi Commission for Tourism and National Heritage (SCTA)	✓
Ministry of Communications and Information Technology (MCIT)	✓
Ministry of Environment Water and Agriculture (MEWA)	✓
Ministry of Municipal and Rural Affairs (MOMRA)	✓
Saudi Electricity Company (SEC)	✓
General Authority for Meteorology and Environment	✓
Saudi Wildlife Authority	✓
Al Jouf Municipality (Amana)	X

It should also be noted that the MEIM, the SEC, the King Abdullah City for Atomic and Renewable Energy (KACARE) and Saudi Aramco are working in partnership to implement the target of 9.5 GW of renewable energy by 2023. These partners are working in collaboration and have attended regular meetings held in Riyadh to ensure the smooth planning and implementation of projects.

On the basis that the location of the Dumat Al Jandal Wind Energy Park has not yet been publicly disclosed, and the design is only preliminary, consultation with the community and other public stakeholders will be undertaken during the next phase of the development by the IPP. This approach has been implemented by the MEIM. Consultation with the local communities, including vulnerable and potentially disadvantaged groups, will be undertaken during the next phase of development when the scope and envelope of development impacts are better defined. This will help to manage effective consultation by avoiding consultation at a time when the development design is still uncertain.

To ensure the views and opinions of public stakeholders are appropriately considered and can influence the design as required, the consultation results shall be incorporated into an addendum to this ESIA during the next phases of development.

1.7 Environmental Permitting

The development is located within a Saudi Aramco reservation, and therefore the environmental permitting jurisdiction for this development falls under the MEIM. Saudi Aramco Environmental Protection Department (EPD) acts as an independent regulatory function for Saudi Aramco projects, under derogation from the General Authority for Meteorology and the Environment (GAME) and the MEIM.

According to GERRI there is a responsibility on the GAME to coordinate with and monitor authorities licensing activities that could cause environmental degradation to ensure the rules and standards are being appropriately applied. However, there is no specific requirement or article that states the licensing authorities are to provide copies of ESIAs/Approvals to GAME. It is considered, therefore, that the MEIM would determine whether the ESIA/required approvals are provided to GAME, or for GAME to request during any auditing process.

1.8 Report Structure

The structure of the ESIA is as follows:

Chapter 1 Introduction. This chapter provides a basic description of the Park, including the key components of the development and an overview of the processes to be undertaken at the Park.

Chapter 2 Policy, Legal and Administrative Framework. This chapter summarizes the key elements of national, local, and international legislation that apply to the Dumat Al Jandal Wind Energy Park.

Chapter 3 Consideration of Alternatives. This chapter provides a description of the alternatives considered as part of the design development.

Chapter 4 Detailed Description and Layout of the Proposed Development. This chapter provides a description of the development site including details of the process and infrastructure design, plot plans and the different phases of the Park (construction, commissioning, operation and decommissioning) with their proposed schedules (where available).

Chapter 5 Impact Assessment Methodology. This chapter details the criteria applied to the assessment of potential impacts arising from the Park elements described in Chapter 4. It provides definitions of impact magnitude and significance as they apply to the potential effects on environmental and social aspects.

Chapter 6 Meteorology, Climate and Air Quality. This chapter presents the results and conclusions of the assessment of ambient air quality and local climate in the vicinity of the facility in order to establish baseline conditions, and the predicted impacts resulting from air emissions (including greenhouse gases, where appropriate) during the various stages of development of the Park.

Chapter 7 Soils and Geology. This chapter details the geological conditions of the development site and presents an assessment of likely impacts upon them arising as a result of the Park.

Chapter 8 Hydrology and Hydrogeology. This chapter details the hydrological and hydrogeological conditions of the development site and presents an assessment of likely impacts upon them arising as a result of the Park.

Chapter 9 Noise & Vibration. This chapter presents the identification of existing noise sources and sensitive receptors that could be affected by the noise generated by the Park, conclusions of the noise baseline survey and assessment of the environmental impacts on receptors resulting from noise generated during the lifetime of the Park (in light of applicable criteria, existing noise levels in the area and modelling based predictions).

Chapter 10 Landscape and Visual. This chapter identifies potential impacts upon landscape and visual receptors within the defined Study Area surrounding the development site and makes an assessment of expected impacts upon them.

Chapter 11 Terrestrial Biodiversity. This chapter details the field investigation and literature review, the baseline assessment and presents the evaluation of the potential environmental impacts to ecological receptors during the lifetime of the Park.

Chapter 12 Archaeology and Cultural Heritage. This chapter presents the findings of the baseline investigation of regional and local archaeological and cultural heritage assets and presents an assessment of predicted impacts upon them during the lifetime of the Park.

Chapter 13 Traffic and Transport Infrastructure. This chapter includes a description of the existing transport infrastructure and traffic, and an assessment of the potential impacts of the Park on the usage and demands on transport systems.

Chapter 14 Socio-Economic Aspects. This chapter includes a general description of the socio-economic characteristics on a national, regional and local level including demography, economic activity, employment, infrastructure, land use and education. Each characteristic is assessed subjectively based on a review of existing published information.

Chapter 15 Utilities Infrastructure and Usage. This chapter provides a description of the existing utilities, and evaluation of the utility infrastructure and usage impacts associated with the Park.

Chapter 16 Waste Management. This chapter presents the findings of the baseline investigation detailing the waste management facilities that are available for the Park. The potential environmental impacts resulting from waste management during the lifetime of the Park are evaluated.

Chapter 17 Health and Safety Aspects. This chapter presents a description of the potential health and safety issues associated with the Park, including impacts on community health and safety.

Chapter 18 Sustainable Development. This chapter includes an analysis of how the sustainable development elements are integrated into life cycle phases of the Park.

Chapter 19 Cumulative Impacts Assessment. This chapter includes an assessment of the cumulative effects that are likely to result from the Park on all affected environmental and socioeconomic conditions including other existing, approved and/or planned projects in the region that could reasonably be expected to have a combined effect.

Chapter 20 Environmental Monitoring and Management Plan. This chapter presents guidelines and recommendations on the preparation of the environmental monitoring and management plan.

Chapter 21 Environmental Emergency Response Plan. This chapter presents guidelines on the preparation of the environmental emergency response plan.

Chapter 22 Conclusion. This chapter summarizes the assessment of impact and the residual impacts after the implementation of mitigation; and recommendations for further assessment during the next stages of design.

Chapter 23 Abbreviations & Acronyms. This chapter comprises a list of abbreviations and acronyms contained within the ESIA Report.

1.9 References

Jacobs Zate (2017a). Phase 1: Environmental Assessment Legislation and Guidelines Review

Jacobs Zate (2017b). Dumat Al Jandal Wind Energy Park Phase 2 Fatal Flaw Analysis and Baseline Survey

Jacobs Zate (2017c). Dumat Al Jandal Wind Energy Park Environmental and Social Impact Assessment Terms of Reference

2. Policy Legal and Administrative Framework

2.1 Introduction

This chapter provides a summary of the environmental legislative framework relevant to the Kingdom of Saudi Arabia. As the development will potentially seek international financing, this chapter references the international guidance, standards and instruments of the World Bank Group, specifically the International Finance Corporation (IFC), and the Equator Principles. In accordance with the requirements of the IFC, the development shall consider the utilization of Best Available Techniques (BAT) for environmental control where applicable.

The development is located within a Saudi Aramco reservation, and therefore the environmental permitting jurisdiction for this development falls under the Ministry of Energy, Industry and Mineral Resources (MEIM).

The legislation, guidelines and standards relevant to the development are used as a basis for screening and evaluating the development's impacts. These guidelines and standards are presented as a summary. The full and most recent legislation will be consulted prior to undertaking the assessment and the implementation of any mitigation or monitoring plans.

2.2 International Legislation and Standards

The arrangements for the financing of renewable energy developments in the Kingdom of Saudi Arabia are currently under review, but the developments may be funded by third party financing from the international markets. As a result, the lending banks require an ESIA to be undertaken in accordance with international environmental development standards, particularly those of the World Bank, IFC and the 'Equator Principles'. This section presents an overview of the environmental assessment standards and policies expected to support applications for international financing.

2.2.1 World Bank

The World Bank Group is a family of five international organizations that provide finance in the form of loans and assistance to developing and transition countries. The Group focuses its efforts on the fields of human health, agriculture and rural development, environmental protection, infrastructure, large industrial construction projects and governance. The Group aims to "*end extreme poverty within a generation and boost shared prosperity*".

The World Bank Group provides financial assistance through different means, including, but not limited to, interest free loans and grants, insurance against risk, debt financing, concessional financing and others.

2.2.2 The organizations that make up the World Bank Group are:

- International Bank for Reconstruction and Development;
- International Development Associated;
- International Finance Corporation (IFC);
- Multilateral Investment Guarantee Agency; and,
- International Centre for Settlement of Investment Disputes.

The IFC is the most relevant to the potential financing of proposed renewable energy power plant developments in the Kingdom of Saudi Arabia and is considered further in this report. It is the private sector arm of the World Bank Group with the aim of advancing economic development by investing in strictly for–profit and commercial projects which reduce poverty and promote development.

The World Bank has the following Safeguard Policies to reduce or eliminate the negative environmental and social impacts of potential projects, and improve decision making:

- Environmental Policies
  - Operations Policy / Bank Procedure (OP/BP) 4.01: Environmental Assessment;

- OP/BP 4.02: Environmental Action Plans;
- OP/BP 4.04: Natural Habitats;
- OP 4.07: Water Resource Management;
- OP 4.09: Pest Management; and,
- OP 4.36: Forests.

- Social Policies
- OP/BP 4.12: Involuntary Resettlement;
- OP 4.10: Indigenous Peoples; and,
- OP 4.11: Physical Cultural Resources.

- Other Policies
- OP/BP 4.00: Piloting the Use of Borrowers System; and,
- OP/BP 17.50: Bank Disclosure Policy.

The World Bank has developed an Environmental Assessment Sourcebook: Volume 3 – guidelines for environmental assessment of energy and industry projects. The purpose of the sourcebook is to assist all involved in environmental assessment. The World Bank also has a set of guidelines and guides identifying good practice approaches.

The World Bank's Environmental and Social Framework (ESF) set out the World Bank's commitment to sustainable development through its Policy and a set of Environmental and Social Standards. The framework applies to projects funded by the World Bank, and comprises (World Bank, 2014):

- A vision for sustainable development – this sets out the World Bank's aspirations.
- Environmental and Social Performance Standards – mandatory requirements that apply to the Borrower and projects (see Table 2-1).

In August 2016, the World Bank's Board of Executive Directors approved a new ESF to help protect people and the environment in the investment projects it finances. The expanded protections in the framework include comprehensive labor and working condition protections and community health and safety measures that address road safety, emergency response and disaster mitigation. It also includes a responsibility to include stakeholder engagement throughout the project cycle, and a non-discrimination principle augmented by a new mandatory World Bank Directive that lists examples of vulnerable and disadvantaged groups and explicitly requires staff to assist the borrower to consider, mitigate, and manage related issues. The new ESF is scheduled to come into effect in early 2018.

Table 2-1: World Bank and IFC Environmental and Social Performance Standards

Performance Standard	IFC Performance Standards	Comment
Performance Standard 1	**Assessment and Management of Social and Environmental Risks and Impacts.** Requirements: a methodological Environmental and Social Management System (ESMS) to manage environmental and social risks and impacts on an ongoing basis. Objectives: ▪ To identify and evaluate environmental and social risks and impacts of the project. ▪ To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, Affected Communities and the environment. ▪ To promote improved environmental and social performance of clients through the effective use of management systems. ▪ To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately. ▪ To promote and provide means for adequate engagement with Affected Communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.	The following documents demonstrate adherence to this Performance Standard: ▪ Environmental and Social Impact Assessment (ESIA) ▪ Environmental Monitoring Management Plan (EMMP) ▪ Emergency Response Plan (EERP); and ▪ Stakeholder Engagement Plan (SEP) and ESIA Socio – Economic Chapter The IPP will establish an ESMS relevant to the Project and support any ongoing management and reporting as required Saudi Aramco will use the ESMS to manage the implementation of the actions necessary to meet the applicable requirements of all Performance Standards. Stakeholder engagement will be carried out by the IPP during the detailed design stage in order to gather information with which to make informed decisions.

Performance Standard	IFC Performance Standards	Comment
Performance Standard 2	**Labor and Working Conditions** Requirements: to outline working conditions, management of the worker relationship and occupational health and safety, plus protecting the work force, third parties and the supply chain. Also requires implementation of a guidance note by IFC and the European Bank for Reconstruction and Development (EBRD) on '*Workers' accommodation: processes and standards*'. Objectives: ▪ To promote the fair treatment, non-discrimination, and equal opportunity of workers. ▪ To establish, maintain, and improve the worker-management relationship. ▪ To promote compliance with national employment and labor laws. ▪ To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain. ▪ To promote safe and healthy working conditions, and the health of workers. ▪ To avoid the use of forced labor.	Chapters 14 and 17 of this ESIA (Socio-Economic Aspects and Health & Safety) identify potential impacts that the Park could have upon the health and safety of the workers and working conditions, and propose measures to manage and monitor these aspects. This includes the risk of increased incidence of communicable and vector-borne diseases will be assessed in accordance with the IFC EHS General Guidelines: Construction and Decommissioning (2007). The recommendations put forward in these chapters have been incorporated into the EMMP and the EERP as appropriate. It will be the responsibility of the IPP to take the recommendations made in the ESIA, EERP and the EMMP forward and to update these as required during the lifetime of the Park. A construction management plan will be developed by the IPP and implemented during the detailed design and construction phases of the development. This plan will include standards for worker accommodation and shift patterns, safeguards for the local community and will be reviewed as the development commences.
Performance Standard 3	**Resource Efficiency and Pollution Prevention** Requirements are to outline: Resource Efficiency (Greenhouse Gases and Water Consumption, Waste); and Pollution Prevention (General, Hazardous Materials Management and Pesticide Use and Management). Objectives: ▪ To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities. ▪ To promote more sustainable use of resources, including energy and water. ▪ To reduce project-related greenhouse gas emissions.	Chapter 3 (consideration of alternatives) includes an assessment of the key strategic and technological alternatives that have been considered for the Park, and the integration of Best Available Techniques (BAT) principles within the facility design in order to minimize significant impacts. Chapter 6 includes an assessment of Greenhouse Gas Emissions. The assessment will consider Scope 1 and 2 emissions, and the energy off-set generated by the wind energy power plant. This assessment will also determine the eligibility of the development to generate CER units. Saudi Aramco's Water Conservation Policy (INT-11) requires a Water Systems Optimization Assessment Study for Category 3 projects. This has been considered in Chapters 8 and 15. The IPP will be required to comply with BAT requirements during the detail design and construction phases of the Park, where applicable. The construction management plan to be prepared by the IPP will include plans for the efficient use of resources.

Performance Standard	IFC Performance Standards	Comment
Performance Standard 4	**Community Health, Safety and Security** Requirements are to outline: to outline community health and safety (design and materials management and safety, ecosystem services, disease control and emergency preparedness and response) and security personnel. Objectives: ▪ To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances. ▪ To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the Affected Communities.	Chapters 14 and 17 include an assessment of potential impacts that the Park could have upon workers and community health, and propose measures to manage and monitor those impacts. The recommendations suggested in these chapters have been incorporated into the EMMP and EERP where appropriate. Impacts on local grazing and transient herders have been assessed in Chapter 14. The IPP will be responsible for complying with the recommendations made in the EMMP and the EERP during the construction, operation and decommissioning phases of the development. The most significant impact of the Park upon public health and safety will be a result of increased road traffic accidents due to increased volumes of construction traffic. A traffic management plan will be developed and implemented by the IPP during the detailed design and construction phase of the development in order to minimize impacts from construction traffic upon community health and safety.

Performance Standard	IFC Performance Standards	Comment
Performance Standard 5	**Land Acquisition and Involuntary Resettlement** Requirements: Deals with project related land acquisition and restrictions on land use. This applies to involuntary resettlement (includes physical displacement and economic displacements). Includes special requirements which deal with compensation and benefits for displaced persons, community engagement, resettlement and livelihood restoration planning and implementation, physical and economic displacements, and private sector responsibilities under government-managed resettlement. Objectives: ▪ To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs. ▪ To avoid forced eviction. ▪ To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. ▪ To improve, or restore, the livelihoods and standards of living of displaced persons. ▪ To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.	The proposed development site is located within a Saudi Aramco Reservation within approved Land Use Permit (LUP No. 43980). Chapter 14 (socio economic aspects) includes an assessment of impacts upon grazers and transient herders expected to arise as a result of the Park, including displacement and livelihood restoration. The IPP will be responsible for complying with the recommendations given in the ESIA.
Performance Standard 6	**Biodiversity Conservation and Sustainable Management of Living Natural Resources** Requirements: protection and conservation of biodiversity, management of ecosystem services and sustainable management of living natural resources and supply chain. Objectives: ▪ To protect and conserve biodiversity. ▪ To maintain the benefits from ecosystem services. ▪ To promote the sustainable management of living natural resources through the adoption of practices which integrate conservation needs with development priorities.	Chapter 11 of the ESIA specifically identifies and assesses the existing ecological status of the site and describes the assessment of potential impacts to the biodiversity, habitats and ecosystem services expected to result from the introduction of the Park. Mitigation measures are also proposed and have been integrated into the EMMP where appropriate. The IPP will be responsible for complying with the recommendations given in the ESIA and for ensuring that any conditions related to the preservation of habitat and environment are adhered to.

Performance Standard	IFC Performance Standards	Comment
Performance Standard 7	**Indigenous Peoples** Requirements: Issues surrounding any impacts on lands and natural resources subject to traditional ownership or under customary use, relocation of indigenous peoples from lands, critical cultural heritage, and private sector responsibility where governments are responsible for managing issues of indigenous peoples. Objectives: ▪ To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples. ▪ To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts. ▪ To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner. ▪ To establish and maintain an ongoing relationship based on Informed Consultation and Participation with the Indigenous Peoples affected by a project throughout the project's life-cycle. ▪ To ensure the Free, Prior, and Informed Consent of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present. ▪ To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.	There are no Indigenous Peoples affected by the development of the Park. Impacts on grazers and transient herders have been assessed in Chapter 14 and 17 of the ESIA (Socio Economic Aspects and Health and Safety) and make recommendations for mitigation. The IPP will be responsible for complying with the recommendations given in the ESIA.
Performance Standard 8	**Cultural Heritage** Requirements: protection of cultural heritage in project design and execution, plus project's use of cultural heritage. Objectives: ▪ To protect cultural heritage from the adverse impacts of project activities and support its preservation. ▪ To promote the equitable sharing of benefits from the use of cultural heritage.	Chapter 12 of the ESIA describes and assesses the impact upon cultural heritage assets present within the development site. Intangible aspects of cultural heritage have been assessed in Chapter 14. The IPP will be responsible for complying with the recommendations given in the ESIA and implementing the 'chance find' procedure with regard to the discovery of previously unknown cultural heritage assets.

2.2.3 International Finance Corporation (IFC)

2.2.4 Introduction

The IFC is an international financial institution which offers investment, advisory and asset management services to encourage private sector development in projects. It was established in 1956 as the private sector arm of the World Bank Group to advance economic development by investing in strictly for-profit and commercial projects which reduce poverty and promote development.

The IFC has a sustainability framework that consists of the IFC policy on environmental and social sustainability, performance standards and environmental and social categorization (IFC, 2016). The Performance Standards on Social and Environmental Sustainability (IFC, 2012) are relevant to renewable energy developments in the Kingdom of Saudi Arabia as the standards define IFC clients' responsibilities for managing their environmental and social risks. In addition to these standards, the IFC uses World Bank Group Environmental, Health, and Safety Guidelines (EHS Guidelines) as a technical source of information during project appraisal.

2.2.5 Performance standards

The IFC requires clients to meet the eight Performance Standards listed in Table 2-1 throughout the life of an investment by the IFC.

2.2.6 EHS Guidelines

The IFC developed the World Bank Group EHS Guidelines to provide technical reference documents with general and industry-specific examples of Good International Industry Practice as defined in IFC's Performance Standard 3: Resource Efficiency and Pollution Prevention. The IFC uses these EHS Guidelines as a technical source of information during project appraisal activities. The following are the key IFC guidelines relevant to renewable energy developments:

- General Environmental, Health, and Safety Guidelines, 2007.
- Environmental, Health and Safety Guidelines for Electrical Power Transmission and Distribution, 2007.
- Environmental, Health and safety Guidelines Wind Energy, 2015.

On applying these guidelines, the IFC expect that when host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification of such an alternative should demonstrate that the choice for any alternate performance level still protects human health and the environment.

In the case of almost all large-scale new build, expansion and development projects an ESIA will be required, particularly where project-related international financing is being sought. A comprehensive ESIA, undertaken to international standards, allows both the project sponsor and the investors to assess the full range of potential environmental and social impacts related to a projects development, operation and decommissioning.

2.2.7 Equator Principles (EPs)

Equator Principles Financial Institutions (EPFI) have adopted the EPs as mandatory in order to ensure that the financed development projects are developed in a manner that is socially responsible and reflects sound environmental management practices. The principles comprise a set of ten ethical lending principles (see Table 2-2) that the Performance Standards and environmental and social policies, standards and guidance of the World Bank / IFC are designed to reflect. The latest EPs (EPIII) align with the IFC Performance Standards and the World Bank Group EHS Guidelines.

The EPs provide a risk management framework adopted by nearly 90 financial institutions and banks in 37 countries (EP, 2011). It aims to determine, assess and manage environmental and social risks in projects, plus ensure projects are developed in a manner that is socially responsible and reflect sound environmental management practices. The EPs recognize the importance of climate change, human rights and biodiversity by seeking to avoid, where possible, negative impacts on project-affected ecosystems, communities and the climate. If impacts cannot be avoided then the impacts should be minimized, mitigated and/or offset (EP, 2011).

For Projects located in Non-Designated Countries, the EPFI assessment process requires compliance with the applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) and the World Bank Group EHS Guidelines (EPs, 2013). The EPs also require compliance with the World Bank EHS Guidelines as the minimum standard and require the implementation of Scope 1 and 2 emissions as defined by the International Panel on Climate Change. Non-Designated Countries are those countries not deemed to have robust environmental and social governance, legislation systems and institutional capacity designed to protect their people and the natural environment. The Kingdom of Saudi Arabia is classified as a non-designated country.

Table 2-2: Equator Principles (EP III, 2013)

Principle	Equator Principles (EP)
Principle 1	**Review and Categorization** Categorization of the project based on the magnitude of its potential risks and impacts in accordance with the environmental and social screening criteria of the IFC. This is aligned with the IFC categorization of projects into categories A, B and C.
Principle 2	**Environmental and Social Assessment** Assessment process to address to the EP's satisfaction, the relevant environmental and social risks and impacts of the proposed Project. The Assessment Documentation should also propose measures to minimize mitigate and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed project. For Category A projects the Assessment Documentation includes an ESIA.
Principle 3	**Applicable Environmental and Social Standards** Compliance with host country legislation / permits is required to be addressed in the first instance. For projects located in Non-Designated Countries, the assessment is required to evaluate compliance with the respective IFC Performance Standards and World Bank Group EHS Guidelines. For projects located in Designated Countries, the relevant host country laws, regulations and permits apply.
Principle 4	**Environmental and Social Management System and Action Plan** An ESMS to be developed and maintained by the Client for all Category A and B Projects. An Environmental and Social Management Plan (ESMP) is also required to address issues raised in the Assessment and incorporate actions required to comply with the applicable standards.
Principle 5	**Stakeholder and Engagement** For all Category A and Category B Projects, effective stakeholder engagement must be demonstrated as an on-going process in a structured and culturally appropriate manner with affected communities and where appropriate other stakeholders. For projects with environmental or social risks and adverse impacts, disclosure should occur early in the Assessment process, in any event before the Project construction commences and on an ongoing basis.
Principle 6	**Grievance Mechanism** For all Category A and, as appropriate, Category B Projects, the client will, as part of the ESMS, establish a grievance mechanism designed to receive and facilitate resolution of concerns and grievances about the project's environmental and social performance.
Principle 7	**Independent Review** For all Category A and, as appropriate, Category B Projects, an independent Environmental and Social Consultant not directly associated with the client will carry out an Independent Review of the Assessment Documentation including the ESMP, ESMS and the Stakeholder Engagement process documentation in order to assist the EPFI's due diligence, and assess Equator Principles compliance.

Principle	Equator Principles (EP)
Principle 8	**Covenants** The client will covenant in the financing documentation: to comply with all relevant host country environmental and social laws; regulations and permits to comply with the ESMP and Action Plan (where applicable), to provide periodic reports to the EPFI demonstrating compliance, and to decommission facilities, where applicable and appropriate, in accordance with an agreed decommissioning plan.
Principle 9	**Independent Monitoring and Reporting** To assess project compliance with the EPs and ensure ongoing monitoring and reporting after Financial Close and over the life of the loan, the EPFIs will for all Category A and, as appropriate, Category B Projects, require the appointment of an Independent Environmental and Social Consultant, or require that the client retain qualified and experienced external experts to verify its monitoring information which would be shared with the EPFIs.
Principle 10	**Reporting and Transparency** For all Category A and, as appropriate, Category B Projects: ▪ The client will ensure that, at a minimum, as summary of the ESIA is accessible and available online; and ▪ The client will publicly report greenhouse gas emission levels during the operational phase for Projects emitting over 100,000 tons of CO_2 equivalent annually.
Annex A	**Climate Change: Alternatives Analysis, Quantification and Reporting of Greenhouse Gas Emissions** Clients are encouraged to report publicly on projects emitting over 25,000 tons. In some instances, public disclosure of the full alternatives analysis or project-level emissions may not be appropriate.
Annex B	**Minimum Reporting Requirements** Details the minimum requirements that the EPFI needs to report annually.

2.3 National Legislation and Standards

2.3.1 The Basic Law of Governance

The Basic Law (Royal Decree No. A/90) is commonly referred to as the Constitution of Saudi Arabia. Article 32 of the Basic Law states: "*The State works for the preservation, protection and improvement of the environment and for the prevention of pollution*".

2.3.2 Public Environment Law 2011 (PEL)

The Public Environmental Law (PEL) was enacted by Royal Decree No. M/34 dated 28/7/1422 H (corresponding to 16 October 2001) and established the general regulatory framework for the development and enforcement of environmental rules and regulations in the Kingdom of Saudi Arabia. Under this law the General Authority for Meteorology and Environment (GAME), previously the Presidency of Meteorology & Environment (PME) has been assigned with the responsibility for the development and enforcement of environmental rules and regulations.

The GAME is therefore responsible for:

- Conducting environmental studies;
- Documenting and publishing the results of any environmental studies;
- Preparing, issuing and reviewing relevant environmental standards;
- Ensuring compliance with relevant environmental standards;
- Working in conjunction with other governmental agencies, establishing plans to deal with environmental disasters;
- Promoting general awareness for the protection of the environment;

- Environmental monitoring; and,
- Updating of environmental standards.

2.3.3 General Environmental Regulations and Rules for Implementation (GERRI)

The Public Environmental Law (PEL) was enacted by Royal Decree No. M/34 dated 28/7/1422 H (corresponding to 16 October 2001) and established the general regulatory framework for the development and enforcement of environmental rules and regulations in the Kingdom of Saudi Arabia. Under this law the General Authority for Meteorology and Environment (GAME), previously the Presidency of Meteorology & Environment (PME) has been assigned with the responsibility for the development and enforcement of environmental rules and regulations.

In respect to the completion of environmental assessments, particular reference should be made to the GERRI (2001) articles presented in Table 2-3.

Table 2-3: General Environmental Regulations and Rules for Implementation (2001) articles

Article	Content
Article 2 – aims of GERRI (2001)	The General Environmental Regulations and Rules for Implementation aim to achieve the following: ▪ preserve, protect and develop the environment and prevent its pollution; ▪ protect public health from activities and acts that harm the environment; ▪ conserve and develop natural resources and rationalize their use; ▪ include environmental planning as an integral part of overall development planning in all industrial, agricultural, architectural and other fields; and ▪ raise awareness in environmental issues and strengthen individual and collective feelings of responsibility for preserving and improving the environment and encouraging national voluntary efforts in this field.
Article 5 – verification of ESIAs by licensing agencies	Licensing agencies must ascertain that the environmental evaluation studies for projects which may cause negative impacts on the environment are done at the project feasibility stage, the agency in charge of implementation of the project shall be responsible for conducting the environmental assessment studies in accordance with the environmental basics and standards determined by the competent agency in the rules for implementation.
Article 6 – implementation of BAT	The party executing new projects, making major modifications to existing projects, or owning projects whose specified terms of investment have expired must utilize the best possible and most suitable technologies for the local environment and use materials which introduce the lowest possible level of pollution to the environment.
Article 8 – adoptions of mitigation hierarchy	Taking into consideration the GERRI, public agencies and persons shall: ▪ rationalize the use of natural resources to preserve and prolong the reserve life of non-renewable resources and to develop renewable resources; ▪ achieve coherence between the bearing capacity of the resources and utilization levels of the various resource categories; ▪ apply recycling technologies and reuse of resources; ▪ develop conventional technologies and traditional systems that are coherent with the local and regional environmental conditions; and ▪ promote the technologies associated with traditional building materials.

Article	Content
Article 10 – consideration of the environment in the planning process	Environmental considerations must be incorporated in the process of planning for development projects, programs and developmental plans for various sectors and the general developmental plan.
Article 11 – conformance to regulations in the design and operation phases	▪ Any person responsible for designing or operating any project or activity must commit to ensure that the design and operation of the project are in conformity with the regulations and standards in force. ▪ Any person involved in work which may result in negative impact on the environment must take all appropriate steps to limit the effects or decrease their potential occurrences.
Article 12 – control of emissions	▪ Anyone performing digging, demolition, construction, or debris and earth transportation works must take necessary precautions for safe storage and transportation of any waste, as well as the proper treatment and disposal of such waste. ▪ All smoke, gases or vapors and solid or liquid residue resulting from the burning of any kind of fuel or similar, whether for industrial, power generation or other activities, must be within allowable limits as permitted in the environmental standards. ▪ The owner of the facility must take all necessary precautions and measures to ensure that there is no leaking or emission of air pollutants to the work place beyond the allowable limits of the environmental standards. ▪ Adequate ventilation requirements must be applied in enclosed and semi-enclosed public places according to the size and space capacity of the place and the kind of activity carried out in the place.
Article 13 – consideration of the environment in the planning process	Environmental considerations must be incorporated in the process of planning for development projects, programs and developmental plans for various sectors and the general developmental plan.

2.3.4 GAME (formerly PME) Environmental Standards

The GERRI were enacted in October 2001, and Appendix 1 of GERRI outlines the Environmental Protection Standards relevant to facilities in the Kingdom of Saudi Arabia.

The GAME (2001) General Environmental Protection Standards for New Facilities (Article 7) are outlined as:

- All new major facilities as well as major modifications to existing facilities shall be designed, operated and maintained so as to avoid exceedances of the ambient environmental standards as promulgated for the Kingdom of Saudi Arabia at the time of approval of the design.
- Each new major facility or major modification of an existing facility shall incorporate the best available technology for control of pollutant discharges and for the disposal of wastes resulting from the operation of the facility.
- All new facilities and modifications of an existing facility shall be designed and operated so as to avoid the discharge of any toxic substance, whether specifically regulated or not, in sufficient quantities to be harmful to public health.

In 2012, the GAME developed a number of draft supplementary Environmental Standards revising in part the General Standards for the Environment issued by the GAME in Appendix 1 to the GERRI. These Standards are listed in Table 2-4.

Table 2-4: Presidency of Meteorology & Environment Environmental Standards

GAME Environmental Standard (PMEES)	Topic
GAME ES 1	Material Recovery & Recycling
GAME ES 2	Mobile Source Emissions
GAME ES 3	Noise
GAME ES 4	Air Emissions for Stationary Sources
GAME ES 5	Prevention of Major Accidents
GAME ES 6	Storage and Material Reclamation Facilities Design and Operation
GAME ES 7	Thermal Treatment and Incineration Design and Operation
GAME ES 8	Waste Acceptance Criteria
GAME ES 9	Waste Classification
GAME ES 10	Drinking Water Quality
GAME ES 11	Biological Treatment Design and Operation
GAME ES 12	Waste Control
GAME ES 13	Waste Handling and Storage
GAME ES 14	Waste Training
GAME ES 15	Waste Transportation
GAME ES 16	Landfill Design
GAME ES 17	Industrial and Municipal Wastewater Discharges
GAME ES 18	Best Practicable Environmental Option for Waste Disposal
GAME ES 19	Ambient Air Quality
GAME ES 20	Ambient Water Quality

Article 6 of the GERRI requires projects to "*utilize the best possible and most suitable technologies for the local environment and use materials which introduce the lowest possible level of pollution to the environment*". Article 7 of the GERRI, General Environmental Protection Standards for New Facilities requires new facilities to: "I*ncorporate the best available technology for control of pollutant discharges and for the disposal of wastes resulting from the operation of the facility*".

Best Available Technology (BAT) is not elaborated further within the GERRI, however, the EU Directive on Integrated Pollution Prevention and Control introduces the definition of BAT used within the ESIA as part of the assessment of alternatives.

2.4 International Environmental Agreements Ratified by Saudi Arabia

The Kingdom of Saudi Arabia cooperates internationally to protect and manage the environment and participates in the work of codification of international environmental law. This commitment is manifested in the signing and ratification of the following International and Regional conventions on the environment[2] (Table 2-5).

[2] Source: http://ec.europa.eu/world/agreements/searchByCountryAndContinent.do?countryId=2149&countryName=Saudi%20Arabia

The agreements are a very important legal instrument for the environment. For example, The Convention on Biological Diversity (Rio) states in Article 14 that the signatories must carry out environmental impact studies for projects that may have potential adverse effects on biodiversity, to prevent or minimize these effects.

Table 2-5: Relevant International Agreements Signed by Saudi Arabia

International Agreement	Date Signed
Paris Agreement to the UN Framework Convention on Climate Change	03/11/2016
13/Convention on the Rights of Persons with Disabilities□12/2006	13/12/2006
International Treaty on Plant Genetic Resources for Food and Agriculture	06/06/2002
Cartagena protocol on biosafety to the convention on biological diversity	24/05/2000
Rotterdam Convention on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade	10/09/1998
Kyoto Protocol to the UN Framework Convention on Climate Change	11/12/1997
International Plant Protection Convention - New revised text approved by Resolution 12/97 of the 29th Session of the FAO Conference in November 1997 - Declaration	07/11/1997
Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982 (UNCLOS)	28/07/1994
United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	17/06/1994
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer	25/11/1992
Convention on biological diversity	05/06/1992
United Nations Framework Convention on Climate Change	09/05/1992
Amendment to the Montreal protocol on substances that deplete the ozone layer (London Amendment)	29/06/1990
Basel Convention on the control of transboundary movements of hazardous wastes and their disposal	22/03/1989
Montreal Protocol on substances that deplete the ozone layer	16/09/1987
Vienna Convention for the protection of the ozone layer	22/03/1985
United Nations Convention on the Law of the Sea (UNCLOS)	10/12/1982
Convention on the conservation of migratory species of wild animals (Bonn Convention)	23/06/1979
Constitution of the Food and Agriculture Organization of the United Nations (FAO)	16/10/1945

2.5 Other Legislation & Guidance Relevant to Saudi Arabia

2.5.1 Wildlife legislation and strategies

The Saudi National e-government portal states that there are several legal instruments and national strategies in the Country to protect the wildlife over and above international instruments to which the Kingdom of Saudi Arabia is party, listing these as:

- The Preserved Areas System and Regulations for Wildlife;
- System and Regulations for Hunting Animals and Wild Bird;
- The National Strategy for Biological Diversity Conservation in the Kingdom of Saudi Arabia; and
- The Convention for Preserving Wildlife in the Six Gulf States.

2.5.2 Sustainability policies

2.5.2.1 Sustainability policy drivers

The principles of sustainable development have been prioritized in global, national, and local government policy as well as the Gulf Cooperation Council in order to ensure steady, balanced and sustainable long-term economic growth. As a result, a number of policies, procedures and guidelines have been generated in order to assist both the public and private sectors, to minimize their impact on the natural and human environment through their decision-making. Identified areas for the improvement of activities towards sustainable behavior are on a wide-ranging scale: from using energy efficiently and reducing greenhouse gas emissions, to using materials and products from sustainable sources in primary production and procurement.

2.5.2.2 Global policy context

Sustainable Development is promoted through international initiatives, including the United Nations Sustainable Development Solutions Network (SDSN), launched by the UN Secretary-General on August 9, 2012. The SDSN aims to create a framework that addresses the challenges of ending poverty, increasing social inclusion and sustaining the planet (UNDP, 2014).

The Solutions Network mobilizes scientific and technical expertise from academic, civil society, and the private sector in support of sustainable development problem solving at local, national, and global scales. The SDSN has launched projects to pilot the rollout of practical approaches to managing the challenges of sustainable development and assist countries in developing sustainable long-term development pathways.

The United Nations Sustainable Development Goals which were adopted on September 25th 2015 aim to end poverty, protect the planet, and ensure prosperity for all as part of a new sustainable development agenda. Each goal has specific targets to be achieved over the next 15 years (i.e. 2030). In total there are 17 development goals (Figure 2-1).

Figure 2-1: United Nations Sustainable Development Goals

2.5.2.3 National policy context

Saudi Arabia's development plans are a quinquennial publication that sets forth the national socioeconomic direction. The strategic document outlines the targeted aims to be reached within the next 5 year timeframe. The Plans are designed to be responsive and tailored to national requirements, given changing dynamics both domestically and abroad. Additionally, they are used as a measuring tool to gauge effectiveness of implementation against the aims (www.mep.sa). The current ratified plan is the ninth Development Plan which covered the period

2010 – 2014. The tenth Development Plan (2015-2019) has been prepared but is yet to be formally enacted into national law.

The key features of tenth NDP are:

- Developing non-oil exports, and increasing their contribution to the total value of exports.
- Encouraging local and foreign strategic partnership to implement investment projects, which contribute to diversification of the production base of the national economy.
- Maximizing the value added of oil and gas resources in all uses and production activities.

Saudi Arabia has witnessed significant progress on development indicators in recent years, a key focus for the government, and this program supports the need for sustainability of approved development. As such, according to UNDP, this program focuses on three major outcomes related to the three pillars of sustainable development:

- Mainstreaming Sustainability into Development Policy: Key priorities are to monitor implementation of the UNDP 2014; devise new sustainable development indicators and integrate sustainable development approaches into development planning; and diversify growth through regional development and knowledge economy and south-south cooperation.
- Green Economy: The development of strategies for transitioning to green economy, with special focus on energy efficiency and renewable energy and in other priority sectors such as water, mining, building, transport, and waste. This has gained great attention in recent years as a way of generating new growth; value added, knowledge based economy; creating green jobs; and increasing competiveness. Global green economy reached record market capitalization in 2010, of $386 billion, led by emerging economies, with great scope for the Kingdom of Saudi Arabia to engage in this trend.
- Social Empowerment: The development of strategies and policies for poverty reduction, including youth and female employment, is of high priority to engender social stability and equitable growth. Strategies are needed to insure inclusive growth with focus on population policies and labor market adaption, as well as enhanced systems of social subsides and social safety nets.

2.5.3 Islamic guidance

2.5.3.1 Islamic Principles for the Conservation of the Environment

The sustainable use of natural resources and the conservation of the environment are Islamic principles pertaining to the right and privilege of all people. Islamic principles hold that the protection, conservation and development of the environment and its natural resources are a mandatory duty to which every Muslim should be committed.

- The Islamic trust of stewardship towards the natural environment is summarized as follows:
- there should be no extravagance, excessive use or over-utilization;
- there should be no illegitimate or unlawful attempt at destroying natural resources; and,
- there should be no damage, abuse, pollution or distortion of the natural environment in any way.

There should be no construction and development of the earth, its resources, elements and phenomena without the improvement of natural resources, the protection and conservation of all existing forms of life, the cultivation of land, and the reclamation and cleaning of the soil, air and water. As ownership of all environmental elements is a common and shared right, it is the responsibility of both individuals, and the ruling authorities, to uphold these duties, especially in terms of prevention or treatment of damage. The state is therefore seen as having the right in Islamic law to hold individuals, organizations, establishments and companies responsible for whatever measures are necessary to protect and conserve the environment and natural resources.

3. Consideration of Alternatives

3.1 Introduction

This chapter provides an overview of the justification for the Park and describes the feasible project and design alternatives that have been considered at this stage of the development. The consideration of alternatives is based on the preliminary engineering design and is assessed against the international lending and client requirements. This includes consideration to the application of Best Available Techniques (BAT) to the development in accordance with the requirements of the General Authority for Meteorology and Environment (GAME – formerly Presidency of Environment and Meteorology) (2001) in addition to International Finance Corporation (IFC) Performance Standards.

The consideration of alternatives also takes into account IFC Performance Standard 3 and the requirements for Resource Efficiency (Greenhouse Gases and Water Consumption) and Pollution Prevention (General, Hazardous Materials Management and Pesticide Use and Management). The objectives for this Performance Standard are as follows:

- To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities;
- To promote more sustainable use of resources, including energy and water; and,
- To reduce project-related Greenhouse Gas (GHG) emissions.

3.2 Project Justification

In April 2016 the Kingdom of Saudi Arabia announced Vision 2030, a plan which expresses the long-term social and economic goals of the country. The *Vision* for the Kingdom of Saudi Arabia is built on three pillars that represent its unique competitive advantages. The Kingdom's status will enable it to build on its leading role as the heart of Arab and Islamic worlds. At the same time, it will use its investment power to create a more diverse and sustainable economy. Finally, the Kingdom will use its strategic location to build its role as an integral driver of international trade and to connect three continents: Africa, Asia and Europe (www.vision2030.gov.sa). The Vision is built around three themes: a vibrant society, a thriving economy and an ambitious nation.

As part of the National Transformation Plan to meet the goals of Vision 2030, the Ministry of Energy, Industry and Mineral Resources (MEIM) launched the National Renewable Energy Program (NREP) to implement 9.5 GW of renewable power by 2023. This target is the principle driver behind the development of renewable energy projects in the Kingdom.

Saudi Aramco had initiated its own program of renewable energy projects prior to the launch of the NREP. As a valued partner in the development of the Kingdom's renewable energy targets, these projects have been accelerated to meet the 2023 national target of 9.5 GW of installed capacity.

The Dumat Al Jandal Wind Energy Park is among the first projects within this program, and therefore is considered to represent a crucial step in the transition from non-renewable to renewable energy within the Kingdom of Saudi Arabia.

3.3 Do Nothing Option

The do-nothing option involves not pursuing the Dumat Al Jandal Wind Energy Park. In this scenario, no change would occur to the environmental or social aspects of the surrounding area. However, the economic, environmental and social benefits of the Park would not be realized. Additionally, the potential offset of diesel currently being burned in the Al Jouf Power Plant and the resulting environmental impacts of this activity (particularly those impacts upon air quality), would not be realized.

The Dumat Al Jandal Wind Energy Park is part of a wider scheme to shift the energy generation mix of the Kingdom of Saudi Arabia away from fossil fuels and towards cleaner energy solutions, not only benefiting the environment but also the economy of the country. As part of the first phase of this wider strategy, it is considered that the Park will be seen as a 'gateway project' to further renewable energy developments within the Kingdom of Saudi Arabia. A failure to pursue the Dumat Al Jandal Wind Energy Park would prevent optimization of the economic value of petroleum resources.

Therefore, the Park seeks to follow internationally accepted protocols and relevant legislation, design out where possible environmental and social impacts and where impacts remain, apply project-specific mitigation and monitoring measures as identified in this Environmental and Social Impact Assessment (ESIA). In this way the Park will be developed with an acceptable level of environmental and social impact, and will significantly contribute to the Kingdom of Saudi Arabia's economy.

3.4 Alternative Sites

Saudi Aramco has completed a review of its reservations and the availability of land within its ownership for the development of renewable energy projects which do not conflict with its current oil and gas operations. The sites available for the development of renewable energy projects are therefore constrained by Saudi Aramco land ownership rights.

Under Saudi Aramco's General Instruction Manual Land Use Permit Procedures G.I. 2.716, there is a requirement to apply for a Land Use Permit (LUP) from Saudi Aramco Facilities Planning Department (FPD) to release the land for the Park. Following receipt of the LUP, FPD will conduct a preliminary review of the release request to ensure that the requested land is not needed for existing short-term or planned long-term land uses; and this process involves internal and external consultation.

Through the LUP application process, those sites which have the potential to be developed for renewable energy have been identified and been awarded a LUP. The developer has applied for a Land Use Permit (LUP), and the proposed site for the Park is located in a non-classified area within the approved LUP No. 43980.

3.5 Alternative Development Types

Saudi Aramco has considered the suitability of renewable energy technologies at the Dumat Al Jandal development site, within LUP No. 43980. This assessment has been based on prevailing climatic conditions (i.e. regional wind and solar resource), the proximity of the Park to the Kingdom's power distribution network and other infrastructure.

Based on the availability of a significant wind resource throughout the year, wind energy was assessed as the most appropriate technology for this location.

3.6 Alternative Design

A preliminary masterplan for the development has been developed by Saudi Aramco. However at this stage of the development the final configuration of the wind energy park and the selection of wind turbine generator technologies to be deployed are subject to further design effort by the Independent Power Producer (IPP).

DNV GL[3] (2017) recommends IEC Class III wind turbines as the majority of turbine locations are expected to meet the wind speed criteria for IEC Class III. DNV GL (2017) recommends that the turbine manufacturers be approached at an early stage and that the IEC site classification is reviewed by and discussed with the selected turbine manufacturer.

The Energy Yield Assessment report for the Park has considered four turbine models (i.e. Siemens, Vestas, Gamesa and GE) ranging from 3.3 MW to 3.63 MW. For all the turbines considered, a variety of tower sizes is available giving a range of hub heights. The hub height is generally cost-optimized for each specific site taking account of:

- Increase of mean wind speeds and therefore energy production of the turbine with higher towers;

[3] DNV GL delivers world-renowned testing and advisory services to the energy value chain including renewables and energy efficiency.

- Increased cost of higher towers and consequent increase in foundation costs; and,
- External constraints (e.g. planning restrictions) (DNV GL, 2016).

Hub heights of between 110 m and 135 m have been proposed by DNV GL for the site and are considered to be appropriate from an energy production perspective. Allowing for rotor diameters of 100 m to 140 m, the maximum height of the turbine to blade tip is 205 m (i.e. 135 m + 70 m).

Recent advancements in wind turbine technology suggest that increasing the design 'tip height' of the wind turbines from 175m to 225m will give investors in the Park further flexibility to implement a more optimal technology solution and deliver lower cost of electricity. This revised turbine height has been adopted for the preliminary design and the forms the basis of design for the assessment of environmental impact. A 155 m hub height and a 140 m rotor diameter (i.e. 155 + 70 = 225 m) has been assumed.

The General Authority for Civil Aviation has already been approached about this design change and granted a permit for Wind Turbine Generators with a tip height up to a maximum of 225 m.

During the next phase of the development, there will be a requirement to optimize the engineering design (i.e. turbine manufacturer and power rating, tower height, turbine arrangement), and refine the materials and equipment utilized in the construction of the Park in order to integrate the principles of cleaner production as specified in IFC Performance Standard 3. This optimized design will be considered within the addendum to the ESIA, to be prepared by the IPP.

The objective of this requirement is to promote the conservation of resources and the minimization of impacts associated with construction of infrastructure. During the detailed design phase of the Park, continuous improvement in design should be pursued in order to ensure that energy and resource efficiencies are identified and integrated into the design of the Park wherever possible.

3.6.1 Design Optimization

The preliminary design that has been developed for the Park considered a range of design basis criteria. The basis of design seeks to mitigate potential impacts on environmental and human receptors during design and demonstrates that alternative designs have been considered. The basis of design and the potential impacts which have been mitigated through consideration of alternatives are described further in Section 4.

3.7 Application of Best Available Techniques

IFC Performance Standard 3 requires all Projects to be developed using technically and financially feasible measures that are most suited to avoid, and/or minimize adverse impacts on human health and the environment. This includes consideration of hazardous and non-hazardous chemical pollutants in the solid, liquid, or gaseous phases, pests and pathogens, discharge (solid, liquid or gaseous) to water, air and surface land, greenhouse gas emissions (GHG) emissions, nuisance odors, noise, vibration, radiation, electromagnetic energy, and the creation of potential visual impacts including light. IFC Performance Standard 8 also requires any removal of Tangible feature of cultural heritage to be undertaken using the Best Available Technique (BAT).

The IFC advocates the avoidance of emissions at source whenever possible, and, if not possible, then subsequent minimization of pollution to the extent that the Performance Standard objectives are satisfied.

Efficient use of resources and pollution prevention is required to be considered using technical and financially feasible measures. The IFC definition of technical feasibility is based on whether the proposed measures and actions can be implemented with commercially available skills, equipment, and materials, taking into consideration prevailing local factors such as climate, geography, infrastructure, security, governance, capacity and operational reliability. Financial feasibility should be assessed and tailored to the hazards and risks associated with the nature of the project and consistent with good international industry practice (GIIP).

Within the European Union, the application of the BAT is undertaken on all large industrial installations as defined by Industrial Emissions Directive (IED, 2010/75/EU). The BAT process is implemented using a series of BREF

(Best available techniques Reference documents). Wind energy parks are not currently considered through the BREF documents, although Energy Efficiency is considered more generally for all industrial installations.

As the design of the Park is refined by the IPP, the application of BAT or more broadly the Technical and Financial feasibility review of the design will be undertaken to ensure that the most suitable technology is utilized for the Park. This shall consider all aspects of Environmental and Social sustainability, and shall consider the use of Value Improving Practices for aspects such as Waste, Water and Carbon Emissions.

4. Detailed Description & Layout of the Proposed Development

4.1 Introduction

This chapter provides a detailed description of the Dumat Al Jandal Wind Energy Park (the 'Park'), its layout and ancillary infrastructure, as well as construction schedule, workforce and associated requirements for infrastructure and services. The description has been prepared based on preliminary design information available at the time of preparing the ESIA (DNV GL, 2017a).

The first round of renewable energy projects will be developed under the independent power producer (IPP) model. The IPP will be responsible for developing the final design of the Park.

There is potential for the design of the Park to change under the IPP and should this occur, the ESIA should be reviewed and an Addendum to the ESIA published. Where design assumptions have been made, they are included in the following sections and have been agreed with the project proponent.

4.2 Objectives of the Project

The objective of the Park is to aid the Kingdom of Saudi Arabia in meeting the target of 9.5 GW of renewable energy by 2023 put forward as part of Vision 2030.

The Park is expected to have a total installed capacity of approximately 400 Mega-Watt (MW).

4.3 Site Location

The Park is located to the north of Dumat Al Jandal, Al Jouf Province, northern Saudi Arabia. The developer has applied for a Land Use Permit (LUP), and the proposed site for the Park is located in a non-classified area within the approved LUP No. 43980.

This location has been chosen as the optimal location for wind energy generation, as a result of detailed site analysis and survey by Saudi Aramco against three main selection criteria:

- wind resource;
- availability of land;
- potential to offset hydrocarbon use; and,
- regional development.

Figure 4-1 shows the site location.

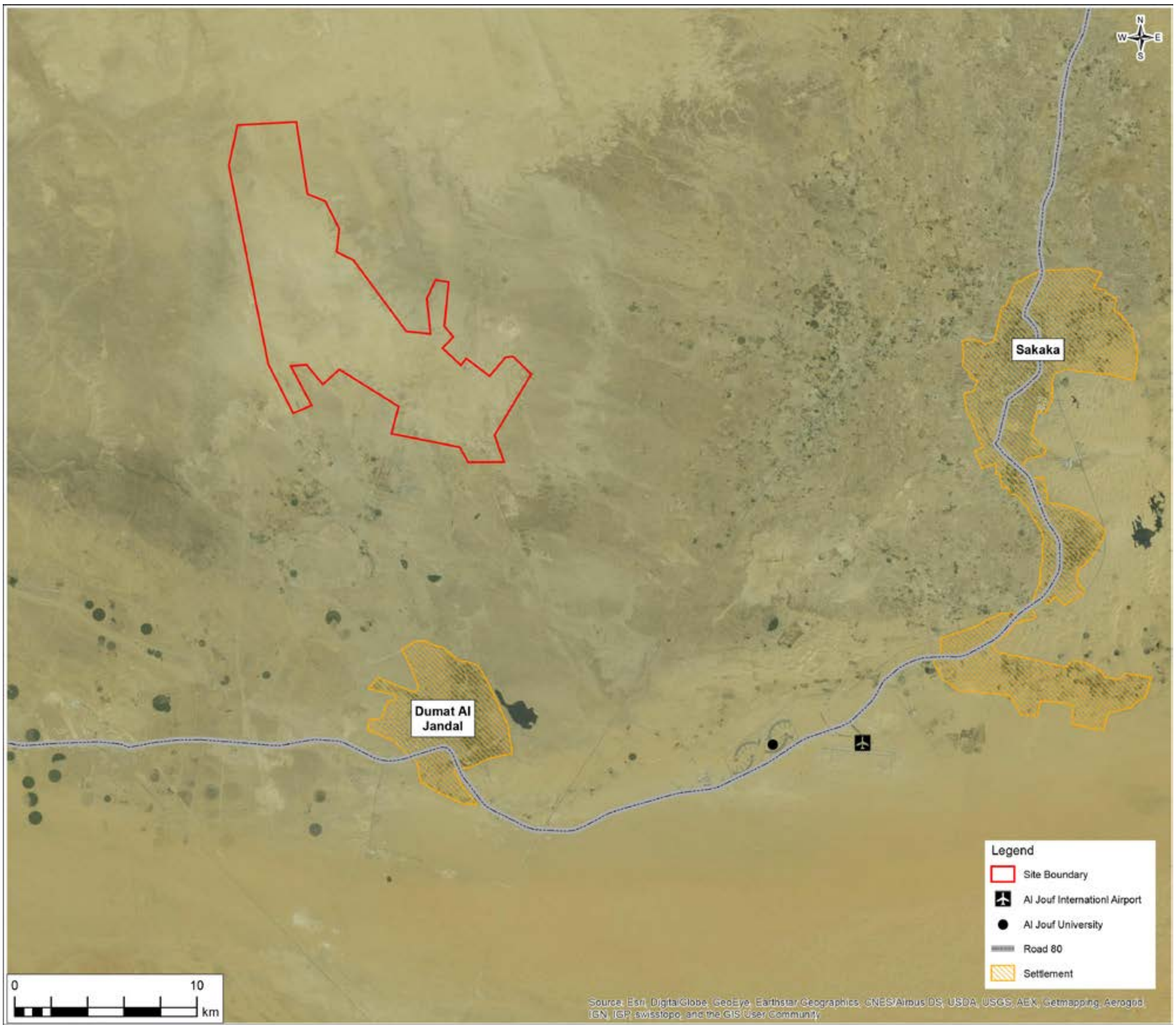


Figure 4-1: Site Location

4.4 Physical Characteristics of Development Site

The development site is located on a raised, flat plateau at an altitude of between 700m to 800m above sea level. The majority of the desert plateau is characterized by bare rock. Small seasonally inundated patches of vegetative growth occur within the shallow flow paths (i.e. wadis) which convey pluvial run-off during periods of rainfall. There is no single well defined flow path across the plateau within the developable area of the Park. The majority of flow paths on the plateau are defined as minor and the only major wadis are located on the edge of the plateau, particularly to the south and east. The flows draining from the plateau form multiple small scale localized wadi channels around the perimeter of the Park. These drain into more clearly defined major wadi channels off-site.

The surrounding landscape to the north, east and south ranges between 100m to 200m below the height of the development site. Due to this sharp drop-off in height, the edges of the plateau are typically characterized by large boulder scree slopes at 45^{o} angle, or steeper, with little to no vegetation. The plateau gives way to sheer cliff edges along some sections of the northern edge where a vast basin lies below the site. This basin lies within the developable area of the Park and has been accounted for in the preliminary design.

4.5 Development Site Layout

4.5.1 Wind Turbine Layout

The preliminary design for the Park recommends the layout and spacing of the wind turbines following various modelling studies and energy yield assessments (DNV GL, 2017a; DNV GL, 2017b). The proposed configuration has been developed in full consideration of a set of design criteria, developed by the project proponent. These criteria ensure the avoidance of potential impact on environmental and human receptors by influencing the design of the project, reduce capital expenditure costs and improve constructability. These design criteria are described further in the following sections.

4.5.1.1 Exclusion Zones

During the pre-feasibility stage of the development, a flood risk analysis was carried out by AECOM (2016). This analysis identified wadi channels at the boundary of the development site where flood water drains from the plateau on which the Park would be located, to the land located at lower elevations to the south of the development site, and a sink hole to the north-east of the development site which also holds surface water during flood events (Figure 4-2).

The Park is located on a flat plateau and as reported in the hydrology and flood risk assessment (AECOM, 2016), there are no major wadi channels crossing the developable area, however minor wadi channels and flow paths are found around the site. The project proponent has specified that the preliminary design should avoid the positioning of turbines within the wadi flow paths. This to avoid potential impacts of scour and erosion and modifications to surface water drainage patterns.

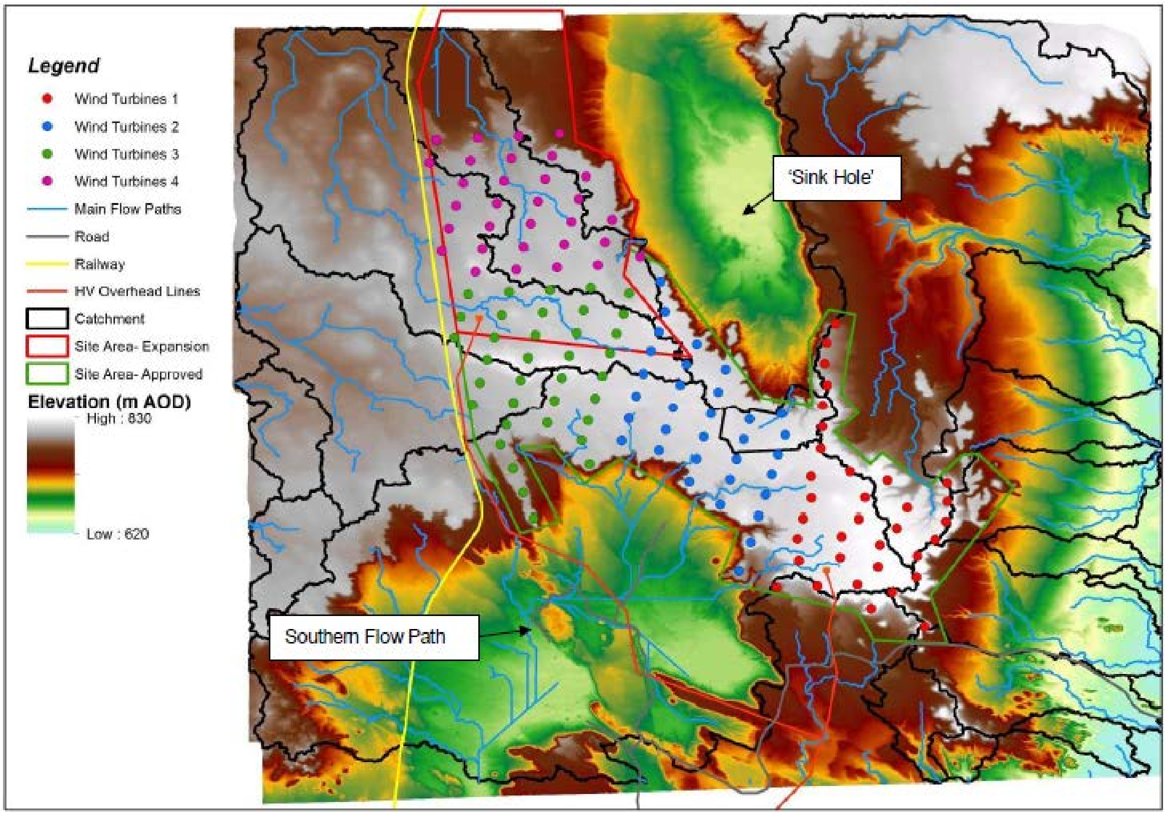


Figure 4-2: Terrain and Catchments within the wider regional area

4.5.1.2 Set Back Distances

The project proponent has specified that the preliminary design should include the following setbacks:

- 1000 m from inhabited properties, to mitigate for potential shadow flicker, noise and direct visual effects. This figure was provided as an administrative constraint;
- 200 m (corresponding roughly to the sum of the hub height and half of the rotor diameter for the selected turbine) from the main primary and secondary roads; and,
- 70 m from the site boundaries (e.g. the whole turbine including blade tips shall remain within the site boundary.

4.5.1.3 Slopes

The project proponent has specified that the preliminary design should avoid the positioning of turbines on terrain with a slope of 10 degrees or greater. This is to reduce construction costs and improve constructability.

4.5.1.4 Turbine Spacing and Layout

The spacing of turbines is a critical design aspect for a wind power plant. A minimum inter-machine spacing of 5 rotor diameters (D) is often quoted by manufacturers. This can be modified and reduced further once the meteorological conditions at a site are known.

A provisional spacing of 3.5 D to 4.0 D across the prevailing wind direction and 7.5 D to 8.0 D in the prevailing wind direction is a sensible compromise for minimum machine spacing, considering the Dumat Al Jandal Wind Energy Park site characteristics (DNV GL, 2017a). Although the proposed height of the turbines has been increased from 175 m to 225 m, the spacing and layout of the turbines has not changed at this stage.

The proposed turbine layout is illustrated in Figure 4-3

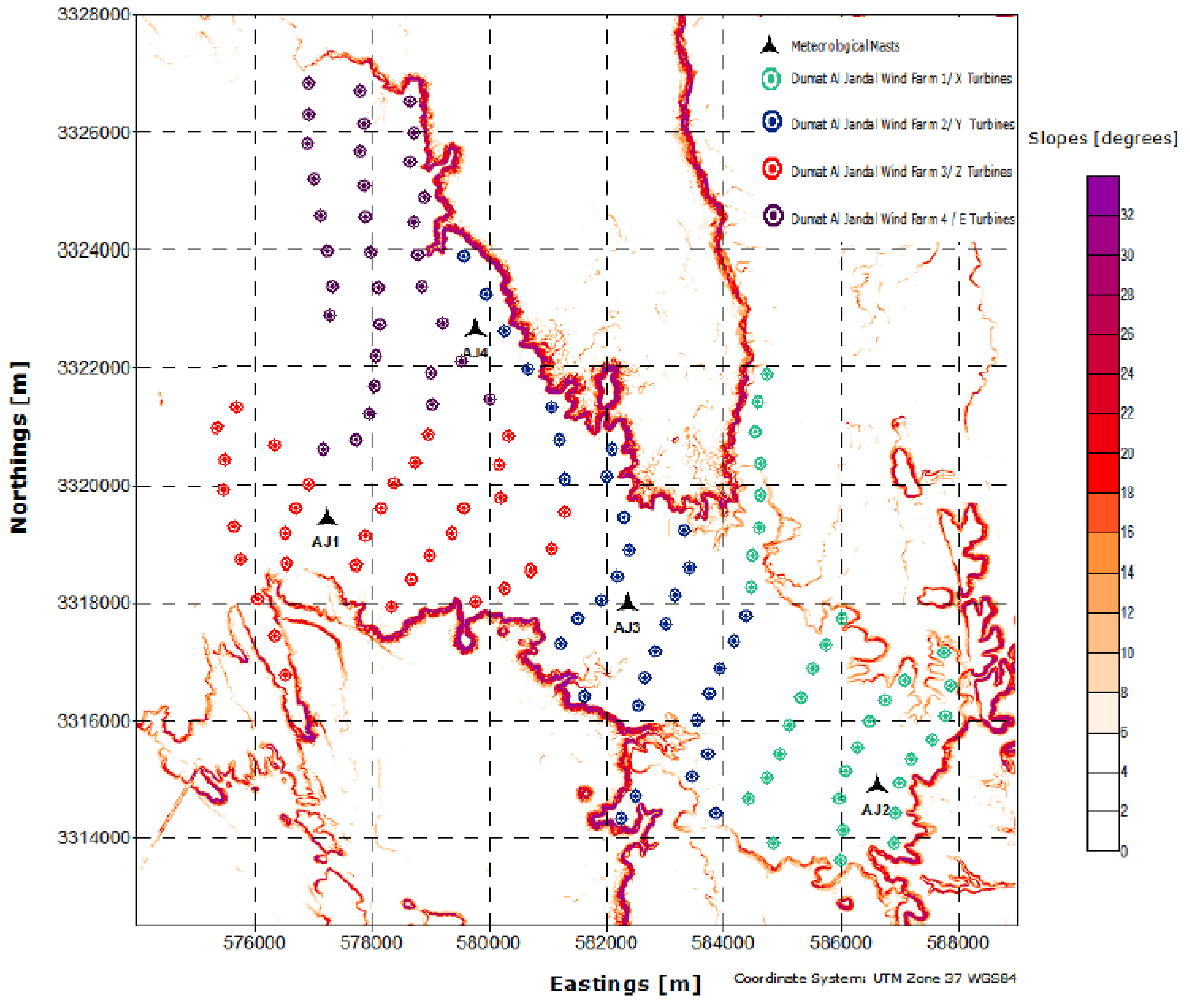


Figure 4-3: Proposed Turbine Layout

4.5.2 Road Infrastructure

The preliminary design developed by DNV GL (2017a) includes an internal road layout. At this stage a single road layout is proposed based on the wind turbine layout. The wind turbines are proposed to be located on higher land on a plateau. In designing the internal road layout, DNV GL (2017a) has positioned tracks in such a way to avoid the steepest gradients located around the perimeter of the site, at the edge of the plateau.

The hydrology and flood risk assessment for Dumat al Jandal (AECOM, 2016) states that the flood risk in the area of the wind turbine locations is generally low. The site access routes linking the wind farm roads to the main highway to the south of the site present a slightly higher risk for scour damage from periodic fast flowing water. These risks can be mitigated by scour protection or other engineering measures where required.

Due to the significant size of the site and complexity of terrain, and its likely construction in Phases, DNV GL (2017a) has developed 3 proposed entrance points off the public road.

DNV GL has designed site road junctions to have a minimum 50 m bending radius to comply with the typical bending radius requirements of abnormal load deliveries. During the next phase of development, which will be undertaken by the IPP, site roads will need to be offset from turbine coordinates by a minimum distance of approximately 25 m to allow sufficient space for turbine foundations, crane pads and safe working areas during construction.

Figure 4-4 shows the proposed access track layout.

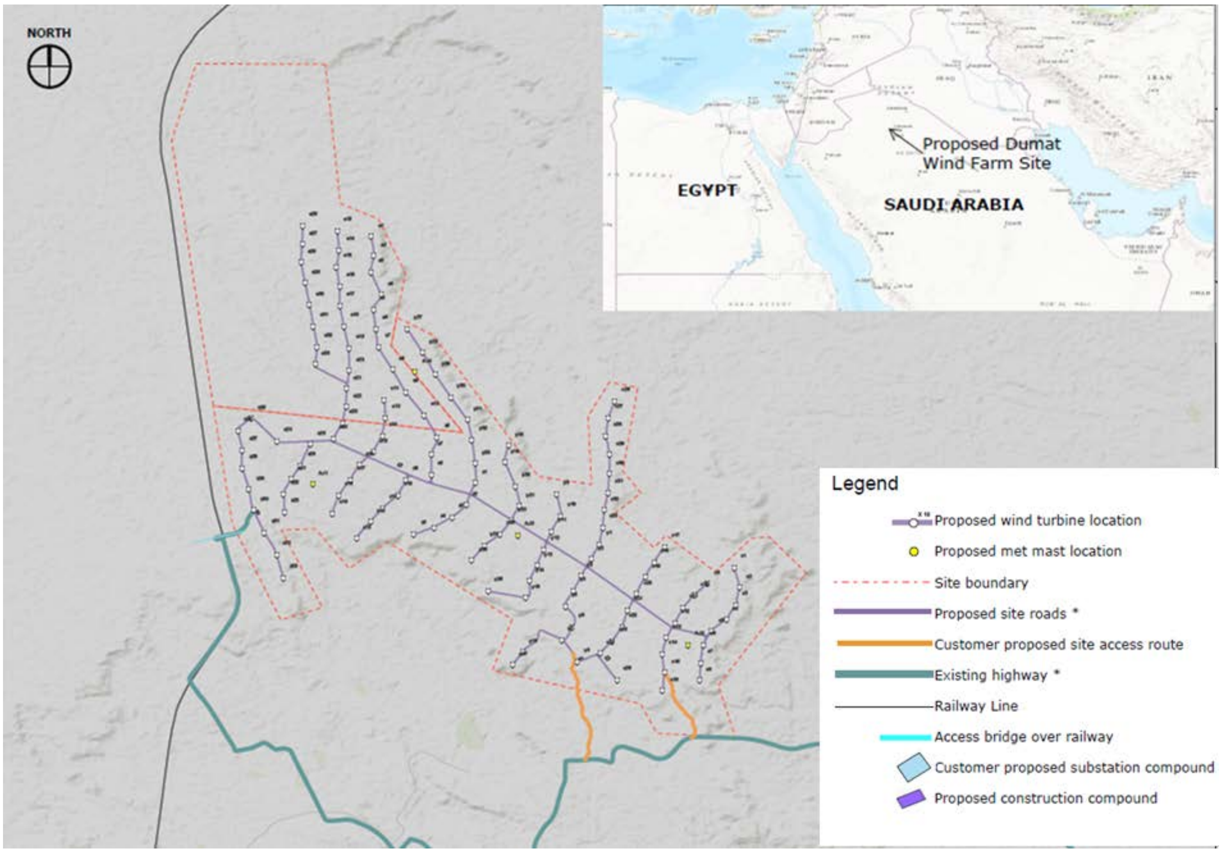


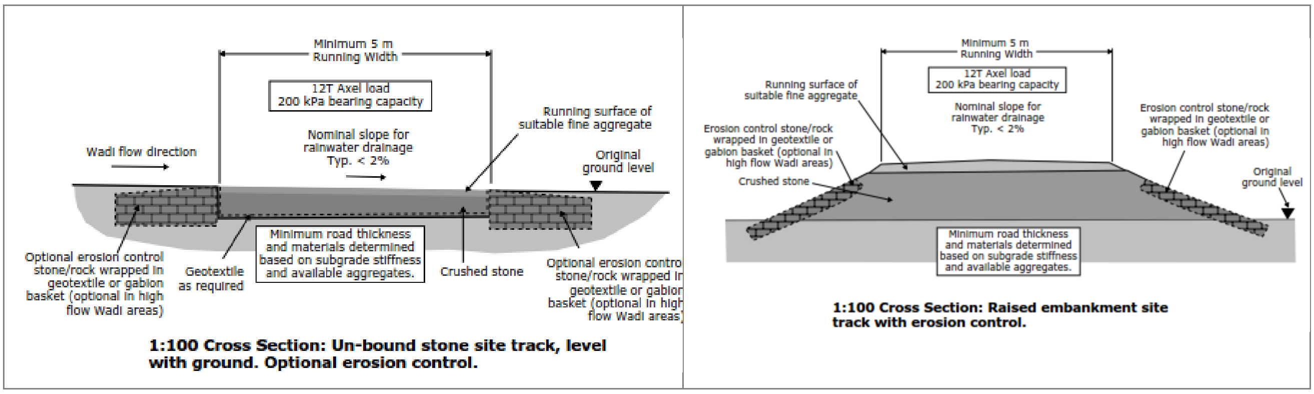
Figure 4-4: Proposed Access Track Layout

4.5.3 Road Design

The design of site roads is dependent on the eventual specification of the turbine supplier and will be influenced by the estimated types and numbers of vehicles, and vehicle loadings. The detailed design will also take account of local ground conditions and the risks of scour and erosion.

Typical site roads will have a minimum running width of 5 m, and a minimum aggregate thickness of 300 mm. There are variants on the design to account for the risks of scour and erosion, and to account for more frequent use by heavy vehicles. The typical cross sections are illustrated in Figure 4-5.

All the site roads will be designed for 12 ton axel load vehicles with a 200 kilopascals (kPa) bearing capacity. Access roads would be offset 25 m from the turbines to allow for turbine foundations, crane pads and safe working areas during construction.



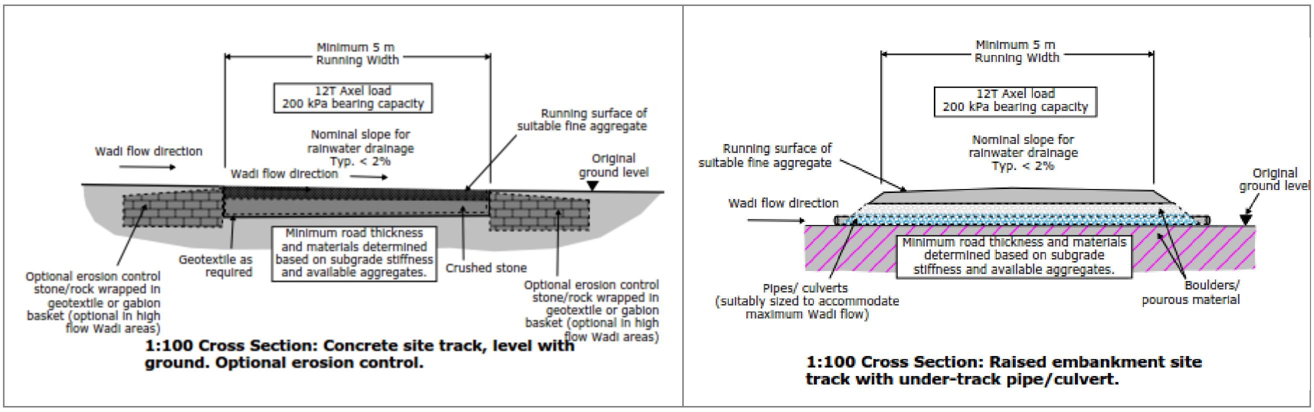


Figure 4-5: Typical site road cross-sections (source DNV GL, 2016)

4.5.4 Developer Compounds

The preliminary design proposed by DNV GL (2017a) recommends two construction compounds; one located on the west of the developable area at the end of the western site access road, and one located to the south of the Park at the end of the central site access road. The proposed dimensions of the construction compounds are 50 m x 100 m. The construction compounds will include site offices, welfare facilities, temporary vehicle parking and storage and the area of the compound will be fenced with security fencing.

There may be additional requirements for further material storage areas for the offloading, storage and pre-assembly of turbine components and this will need to be evaluated with the contractor once the construction plan and strategy has been developed. The proposed location of construction compounds are shown in Figure 4-6.

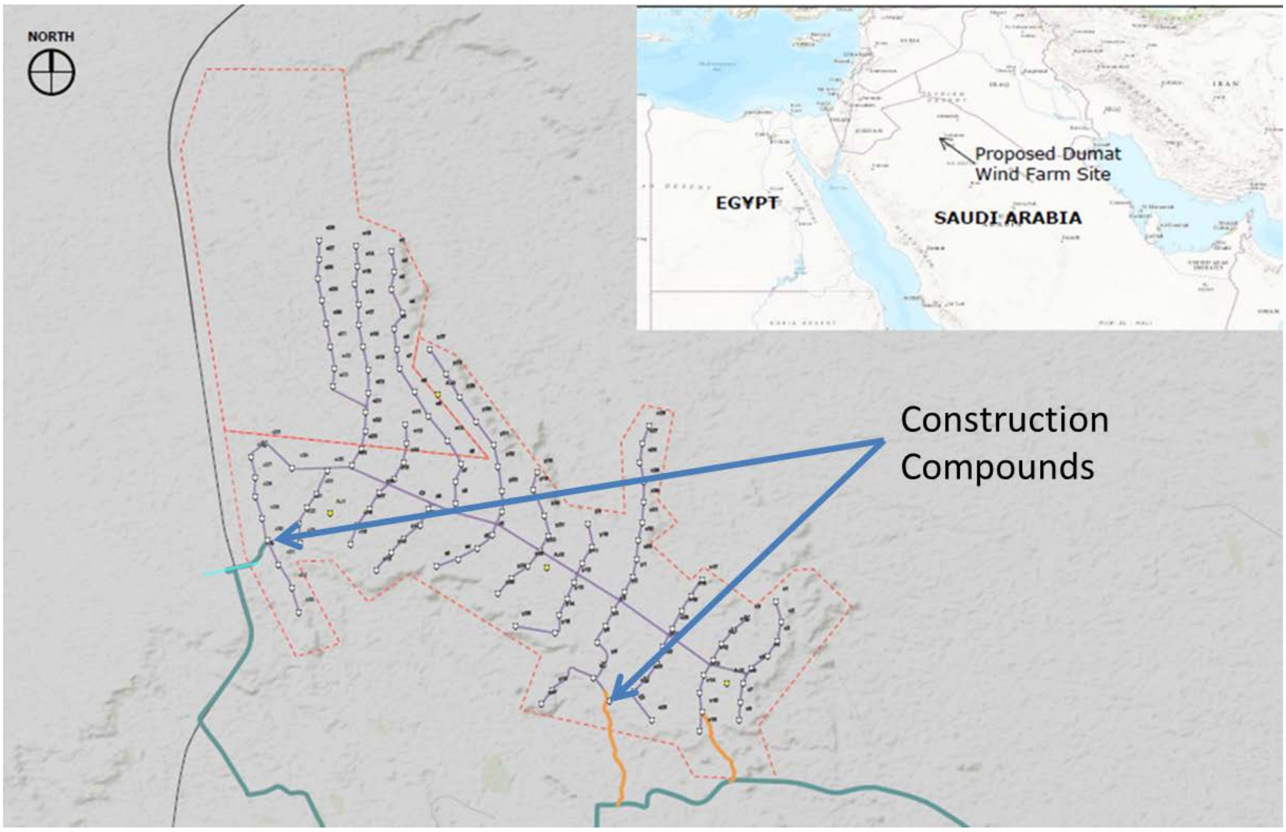


Figure 4-6: Proposed Construction Compound Layout

4.5.5 Wind Turbines

At this stage of design, the turbine manufacturer has not been selected. This will be determined by the IPP during the next phase of development. However DNV GL (2017a) recommends IEC Class III wind turbines as the majority of turbine locations are expected to meet the wind speed criteria for IEC Class III. DNV GL (2017a) recommends that the turbine manufacturers be approached at an early stage and that the IEC site classification is reviewed by and discussed with the selected turbine manufacturer.

The Energy Yield Assessment report for the Park (DNV GL, 2017b) has considered four turbine models (i.e. Siemens, Vestas, Gamesa and GE) ranging from 3.3 MW to 3.63 MW. For all the turbines considered, a variety of tower sizes is available giving a range of hub heights. The hub height is generally cost-optimized for each specific site taking account of:

- Increase of mean wind speeds and therefore energy production of the turbine with higher towers;
- Increased cost of higher towers and consequent increase in foundation costs; and
- External constraints (e.g. planning restrictions)(DNV GL, 2017b).

Hub heights of between 110 m and 135 m have been proposed by DNV GL for the site and are considered to be appropriate from an energy production perspective. Allowing for rotor diameters of 130 m to 140 m, the maximum height of the turbine to blade tip is 205 m (i.e. 135 m + 70 m).

Recent advancements in wind turbine technology suggest that increasing the design ‘tip height’ of the wind turbines from 175m to 225m will give investors in the Park further flexibility to implement a more optimal technology solution and deliver lower cost of electricity. This revised turbine height has been adopted for the preliminary design and the forms the basis of design for the assessment of environmental impact. A 155 m hub height and a 140 m rotor diameter (i.e. 155 + 70 = 225 m) has been assumed.

The General Authority for Civil Aviation has already been approached about this design change and granted a permit for towers up to a maximum height of 225 m.

A typical turbine is composed of blades fixed to a rotor hub and nacelle, a motor, generator and tower. Figure 4-7 shows a typical wind turbine.

1. Foundation
2. Connection to electric grid
3. Tower
4. Access Ladder
5. Wind Orientation Control
6. Nacelle
7. Generator
8. Anemometer
9. Electric or Mechanical Brake
10. Gearbox
11. Rotor Blade
12. Blade Pitch Control
13. Rotor Hub

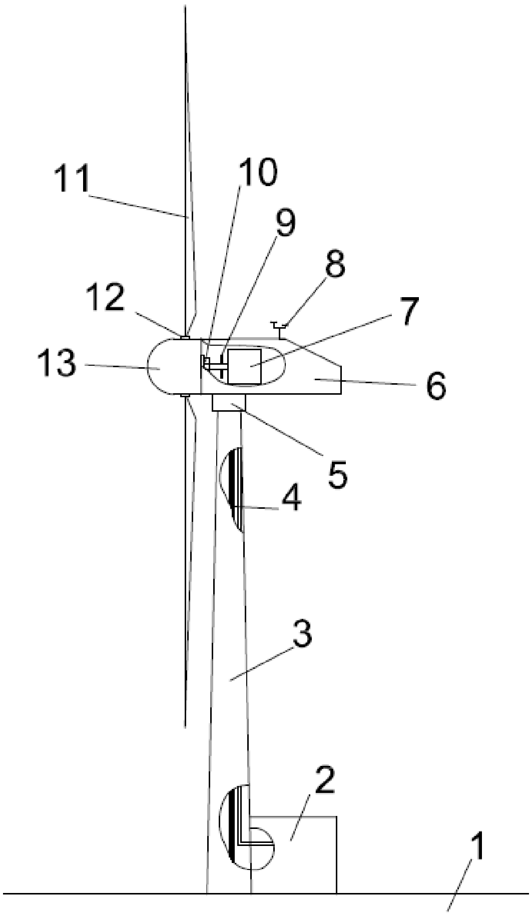


Figure 4-7: Typical Wind Turbine

4.5.6 Turbine Foundations

The preliminary design for Dumat Al Jandal Wind Energy Park includes a review of the geotechnical ground conditions. Based on the ground conditions recorded by Arab Company for Laboratories and Soil (2017), it is expected that conventional gravity-based reinforced concrete foundations for the turbines are plausible for most or all of the turbine locations. This is subject to the findings of detailed ground investigations at each turbine location.

The proposed gravity foundation concept proposed by DNV GL (2017a) comprises:

- A circular reinforced concrete footing of 18.5 m diameter and 1 m thickness, with a 1.4 m thick frustum tapered to a 5.5 m diameter pedestal which is 0.6 m thick;
- Approximately 460 m3 in total, typically with around 100 kg/m3 of high yield reinforcement;
- Formation level of around 3 m below ground level (mbgl), subject to suitable bearing conditions;
- Over-excavation and compacted engineering re-fill in cases where suitable bearing conditions are found below 3 mbgl, but above the depth where piled foundations become more economical (estimated at ~30 locations);
- Assumed non-buoyant;
- Density-controlled backfill, acting as ballast weight on top of the foundation;
- Nominal slopes and falls on the pedestal surface and surrounding backfill to promote drainage away from the turbine;
- An access pathway around the pedestal;
- Export power cables and communications cables passing through ducting and beneath the foundation; and,

- An earthing mat, designed based on site-specific earthing electrical studies.

The detailed design for foundations must account for the eventual specification of the turbine supplier and turbine loads, seismic response of the turbine and localized ground conditions. Although the proposed height of the turbines has increased from 175 to 225 m, the assumptions around the foundations remain the same at this stage. It is currently estimated that each floating foundation will require 460 m^3 of reinforced concrete (i.e. 73,600 m^3 for 160 turbines). Reinforcement is estimated at 100 kg per m^3 (i.e. 46 tons per floating foundation, 7,360 tons for 160 turbines).

The turbines will be constructed on compacted engineering fill, no less than 0.3 m deep and possibly more depending on the soil conditions. This will amount to an estimated 80 m^3 of engineering fill.

Dry mix cement will be transported to site from an approved supplier, in 1 ton bags (approximately 14 bags per flat back delivery truck). The nearest suppliers are the Al Jouf Cement Company near Turaif, approximately 460 km to the north; the Northern Region Cement Company near Turaif, approximately 450 km to the north; and the Hail Cement Company, located approximately 540 km to the south.

There will be a dry mix batching plant located on site during the construction phase. This will be located a minimum distance of 850 m from the construction site offices and worker accommodations.

4.5.7 Turbine Crane Pads and Laydown Areas

To facilitate the safe and organized assembly and installation of turbines, there is a requirement to construct adequate crane pad and laydown areas. Each turbine location will typically require a general crane pad area as well as boom assembly areas and possible blade support fingers or other support / storage areas. The crane pads constructed during the assembly and installation of the turbines will also be utilized during the operational phase of the development (i.e. turbine inspections and maintenance, component replacement).

The design of the crane pads and laydown areas is dependent on the eventual specification of the turbine supplier and will be influenced by the type of cranes and construction plant available, lifting strategies and equipment storage. Figure 4-8 shows a typical crane pad specification for the preliminary design. The crane pad, boom construction areas and blade fingers are estimated to comprise 1 x 1750 m^2 and 2 x 30 m^2 areas respectively. The main crane pad is assumed to be on average 70 m in length by 25 m wide.

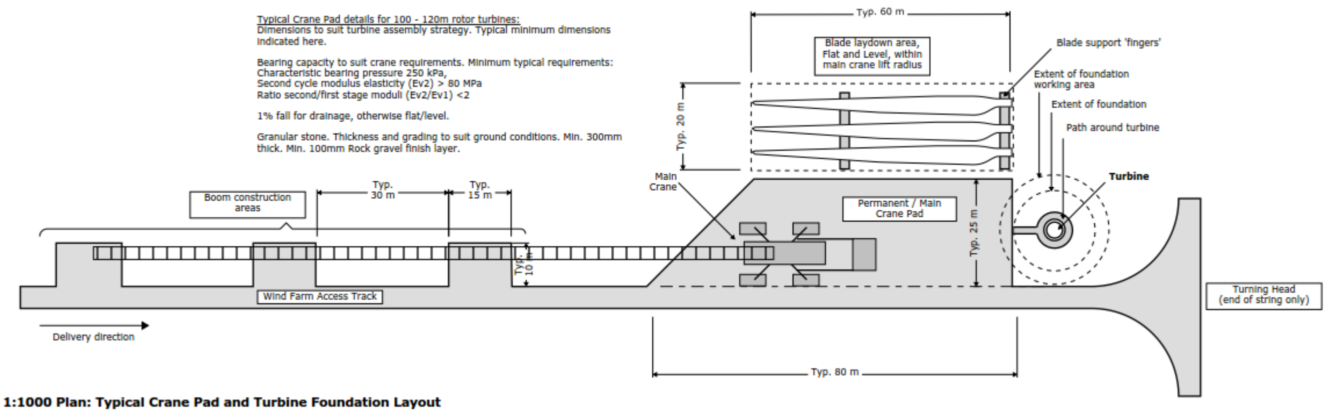


Figure 4-8: Typical Crane Pad and Laydown Area (source DNV GL, 2016)

4.5.8 Electrical Infrastructure

4.5.8.1 Substations

The preliminary design made an assumption that two sub-stations would be installed. The substations are required to collect the electricity generated by the wind turbine generators and step the voltage up from 33 kV to a potential intermediate voltage of 220 kV, which may subsequently be stepped up to 380 kV at the SEC grid substation. However, the preliminary design was modified, changing the 220kv intermediate voltage to 132kv. The proposed location of the 33 kV sub-stations is indicated on Figure 4-9.

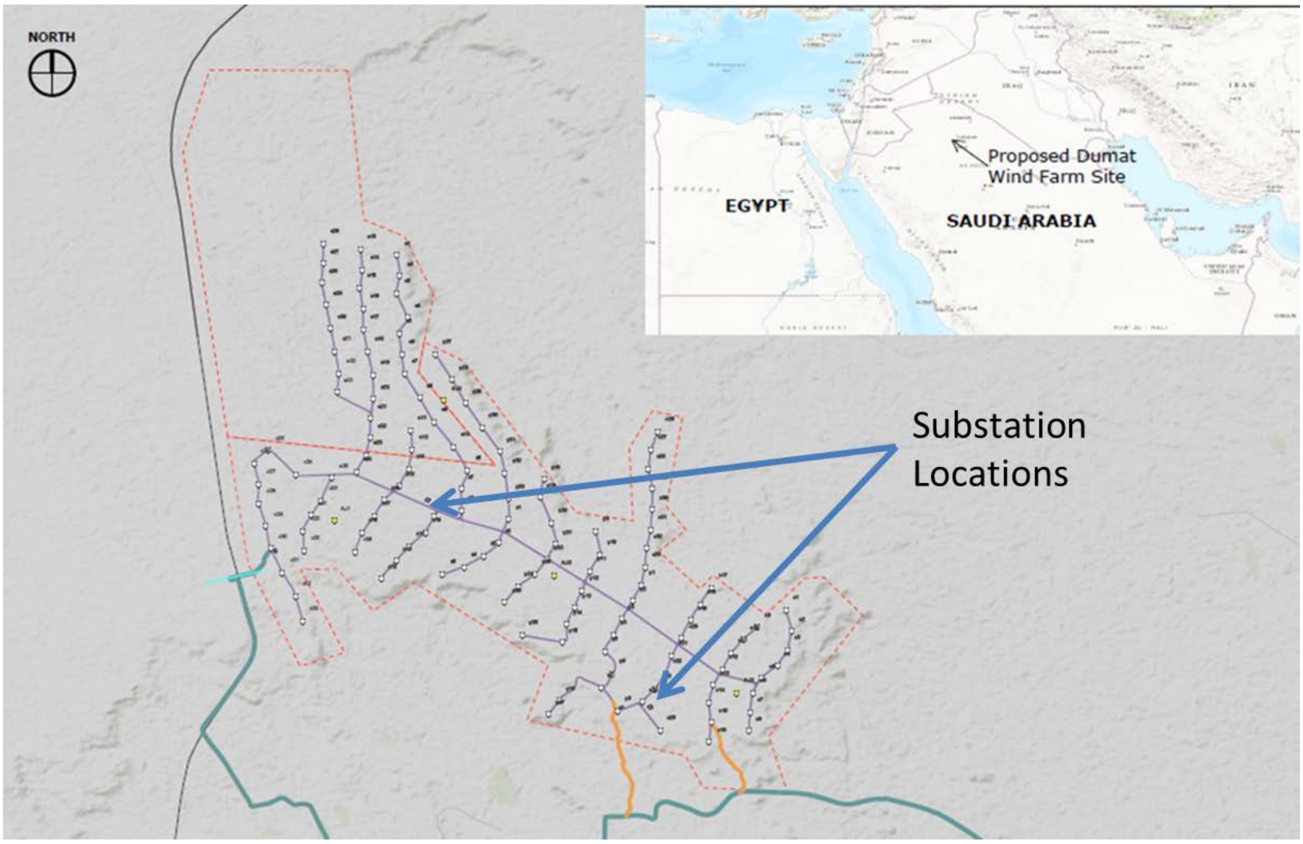


Figure 4-9: Sub-station locations

4.5.8.2 Layout of Medium Voltage Connection

Based on the proposed turbine layout, a preliminary design of the 33 kV network array cables has been developed by DNV GL (2017a)(Figure 4-10). DNV GL (2017a) have assumed the 630 mm^2 copper conductor cables will be used to carry the output of seven or more wind turbines, and 300 mm^2 copper conductor cables have been assumed for carrying the output of up to six wind turbines.

In total, it is estimated that 60,845 m of 630 mm^2 and 76,555 m of 300 mm^2 copper cables will be required.

The Park is located on a flat plateau and as reported in the hydrology and flood risk assessment (AECOM, 2016), there are no major wadi channels crossing the developable area, however, minor wadi channels and flow paths are found across the site. As such, the cable routing proposed by DNG GL (2017a) is relatively straightforward as there is no need to avoid wadi crossings. An overhead line (OHL) solution has been discounted by DNV GL (2017a) as the site is expected to offer harsh environmental conditions to OHL including strong winds.

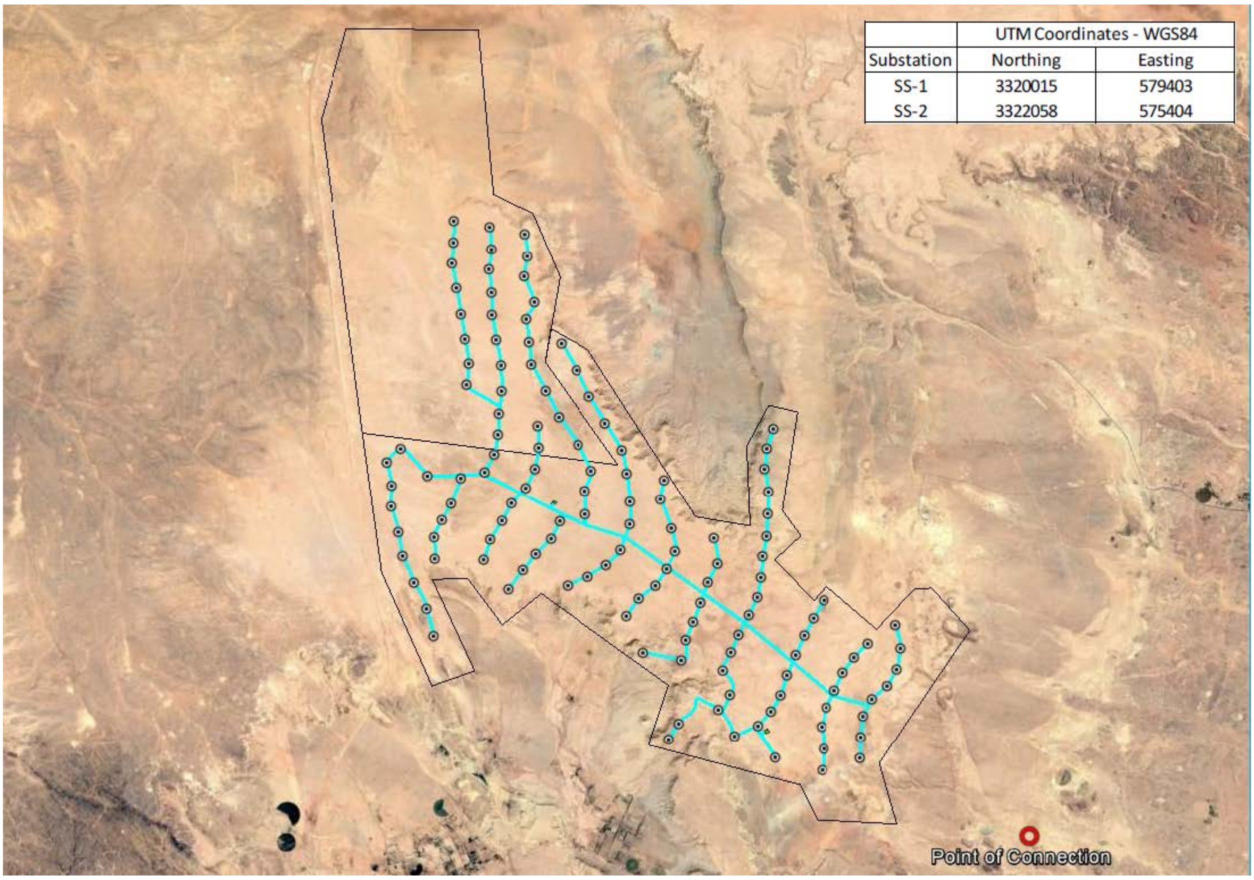


Figure 4-10: Layout of Medium Voltage cables

4.5.8.3 Substation Components

The preliminary design developed by DNV GL (2017a) assumes that the 220 / 33 kV wind farm substations will be outdoor and constructed within an area of 400 m x 400 m. These areas provide enough space for the construction of outdoor air insulated switchgear substations. As stated in the preliminary design, the main and primary components of each of the outdoor substations would be as follows:

- 220 kV disconnectors;
- 220 kV busbars;
- 220 kV circuit breakers;
- 220 / 33 kV power transformers;
- Current transformers;
- Voltage transformers;
- Insulators;
- Earthing system;
- 33 kV disconnectors;
- 33 kV circuit breakers;
- Lighting protection;
- Capacitor bank (optional);
- Inductive reactor (optional); and
- Control building (for relay and protection panels, batteries etc…).

The internal access road has accounted for the electrical equipment such that potential infringement of the electrical equipment safety clearances can be avoided. For example, the delivery of equipment should not need to pass under any electrical cables / busbars / overhead lines, nor be adjacent to them where a crane jib could be swung into the clearance space. This aspect has to be considered both for the construction period and future operations (DNV GL, 2017a).

4.5.8.4 SEC Collector Station

An SEC collector sub-station shall be built by SEC as outlined in the Memorandum of Understanding between Saudi Aramco and SEC. The incoming transmission connection will be located within its own specific locale on site, with bays containing the line isolators, dis-connectors and circuit breakers for each circuit, this being assumed as 220 kV circuit connections to the transmission network (DNV GL, 2017a).

The SEC collector sub-station shall provide the required auxiliary supply for power plant energy consumption. The SEC collector sub-station is likely to be located to the east of the approved LUP and in proximity to the new 380 kV overhead transmission line which is in the process of being constructed, although it’s final position and the alignment of overhead transmission lines has yet to be determined by the SEC.

The SEC is responsible for this new infrastructure, however, as development associated with the Park (i.e.. development that would otherwise not occur). Where practicable, the SEC collector station will be assessed as part of the design of the Park in line with the requirements of the IFC.

4.5.8.5 Meteorological Station

The project proponent will install three permanent meteorological stations to accurately measure meteorological data with calibrated sensors. The stations will be equipped with a dedicated Uninterrupted Power Supply (UPS) and a data back-up system. The location of the meteorological stations will be confirmed during the next phase of design.

The meteorological stations will provide the minimum following measurements:

- Ambient temperature;
- Humidity;
- Wind speed and direction;
- Dust measurement;
- Plane of array irradiation; and,
- Data logger.

4.5.8.6 Vibration Monitoring System

A Vibration Monitoring System (VMS) will be provided for each WTG. This system will comprise of vibration, speed and temperature monitoring racks. Each WTG will be fitted with sensors and monitoring racks that collect and transfer data to the server / engineering workstation located in the 33 kV switching station. The VMS shall be integrated with the site’s supervisory control and data acquisition (SCADA) system.

4.5.8.7 Turbine Control System

A dedicated Turbine Control System (TCS) will be provided for each WTG. The TCS shall be provided with control algorithms to operate WTG during start-up, power production, and shut-down and to obtain optimal power output from wind velocity and direction. This system shall comprise of sensors, actuators, monitoring racks and a server / engineering workstation. Each wind turbine will be fitted with monitoring racks that collect and transfer data to the server / engineering workstation located in the 33 kV switching station. The TCS shall be integrated with the site’s SCADA and ESD system.

4.5.8.8 Remote Terminal Unit

Each WTG will be equipped with a Remote Terminal Unit (RTU) to capture wind turbine information, perform any required computation and transmit data to the SCADA system through a fiber optic communication link.

4.5.8.9 Fiber Optic Cable

A fiber optic cable will be installed to integrate all field devices and systems with the 33 kV switching stations and facilitate the process automation system network. The fiber optic cable will be buried within a utility corridor. It is estimated that approximately 93,830 m of fiber optic cable will be required.

4.5.9 Non-Electrical Utilities

The preliminary design of the Park does not include a design for the 33 kV substations. However, it is anticipated that each station will be provided with a 2 inch utility water pipeline, a PVC septic tank with capacity for 5 persons, a 500 gallon water tank, drinking water coolers and fire extinguishers. Storm water drainage shall be surface drained away from the buildings. The 33 kV switching station shall also be equipped with two 3 ton air conditioning units. As these utilities are classified as development associated with the Park (i.e. development that would otherwise not occur), all non-electrical utilities will be assessed as part of the design of the Park in line with the requirements of the IFC.

4.6 Current Land Use

The Park is located within a Saudi Aramco reservation and therefore falls under the jurisdiction of the Ministry of Energy Industry and Mineral Resources (MEIM). Under Saudi Aramco's General Instruction Manual Land Use Permit Procedures G.I. 2.716, there is a requirement to apply for a Land Use Permit (LUP) from Saudi Aramco Facilities Planning Department (FPD) to release the land for the Park. Following receipt of the LUP, FPD will conduct a preliminary review of the release request to ensure that the requested land is not needed for existing short-term or planned long-term land uses; and this process involves internal and external consultation.

The Park has applied for and received a LUP, and the proposed site is located in a non-classified area within the approved LUP No. 43980.

Unauthorized (non-permitted) livestock husbandry has been recorded within the developable area and adjacent to the Park. A semi-permanent livestock farm was identified within the site, which was staffed by a single expatriate herder, sponsored by a Saudi national (Figure 4-11). This farm consisted of a small pre-fabricated pen, an outhouse and a caravan for accommodation, and had been operational in this location for two years. At the time of writing the ESIA, this herder has demobilized and left the developable area. There is evidence on the site of previous similar land uses some of which appear more permanent, such as stone animal enclosures.

Several plots of semi-formal 'garden' planting were recorded within the developable area. The purpose of this planting is unclear but each plot consists of a post and wire fence surrounding between one and five trees, grown in empty oil drums which have been filled with soil (Figure 4-12). There is evidence of recent maintenance in these locations in the form of hoses and water buckets.

As in many remote areas of the Kingdom of Saudi Arabia, desert camping takes place within the site (Figure 4-13). Camping is a traditional recreational activity enjoyed by many Saudi nationals and typically involves the erection of a tent, building of a fire and the drinking of coffee.

There are three Saudi Aramco meteorological monitoring stations located across the site.

Figure 4-11: Semi-permanent livestock farm located within developable area

Figure 4-12: Semi-formal ‘garden’ plots

Figure 4-13: Desert Campsite

4.7 Neighboring Development

4.7.1 Existing Development

4.7.1.1 Saudi Railway Authority

A railway line operated by Saudi Railway Authority, connecting the Hazm Al Jamid Phosphate Mine to the north with the processing plant at Ras Al-Khair to the east, runs north to south along the western boundary of the development site. This line transports 5 million tons of phosphate by train annually and each train consists of 150 wagons and 3 diesel locomotives. The center line of the railway is approximately 276 m west of the Park boundary.

4.7.1.2 Gypsum Quarry

A Gypsum quarry is located 1.5 km east of the development site boundary. Activities carried out at this facility include the extraction and storage of raw gypsum for sale and processing. The site has been mined for less than fifteen years and is expected to continue operation for the near future.

The licensed boundary of the gypsum quarry is currently unknown, and at this stage it is unclear whether plans exist to expand the quarry further towards the site boundary.

4.7.1.3 Settlements

4.7.1.3.1 Towns

The Dumat al Jandal Wind Energy Park is located to the north and west of the towns of Dumat al Jandal and Sakaka. Dumat al Jandal is located approximately 15km to the south of the Park and Sakaka is located approximately 35km to the east.

4.7.1.3.2 Permanent Settlements

There are scattered farms and small settlements (of no more than two residential dwellings) at various locations surrounding the development site boundary. The closest of these, is located approximately 1.5km from the development site boundary. Structures within these settlements are typically very basic and made from concrete masonry units. Windows on outbuildings and those structures which are obviously non-residential are often unglazed, although some of the more established buildings do feature glazed windows.

4.7.1.3.3 Temporary Settlements

Temporary settlements are found at locations surrounding the development site boundary. These typically consist of prefabricated structures made from concrete masonry units, wood or corrugated steel. These structures are often associated with a livestock pen or small agricultural plot, and are presumed to be used for temporary overnight accommodation during the farming seasons. It is not believed that these buildings are used for permanent residential purposes.

4.7.1.3.4 Receptors

Human receptors within and adjacent to the developable area of the Park, and which have the potential to be adversely affected by the Park, have been identified. These receptors have been considered further in the relevant chapters of this ESIA (e.g. *Chapter 6 Meteorology, Climate and Air Quality, Chapter 9 Noise, Chapter 10 Landscape and Visual, Chapter 11 Terrestrial Biodiversity* (i.e. Ecosystem services), *Chapter 14 Socio-economic Aspects and Chapter 17 Health and Safety Aspects*).

The identified human receptors are described in Table 4-1 and Figure 4-14.

Table 4-1 : Description of Human Receptors

Number	Receptor	Northing	Easting
1	Farms - small cluster of scattered farms with occasional center pivot irrigation systems	29°56'14.25"N	39°50'27.19"E
2	Farms – small cluster of distinct farms with occasional center pivot irrigation systems	29°55'45.08"N	39°47'36.96"E
3	Farm – small isolated farm plot with expired center pivot irrigation system	29°56'49.26"N	39°57'20.72"E
4	Farms – small isolated cluster of outbuildings	29°58'40.68"N	39°48'16.40"E
5	Farms – small individual plot with operational agricultural field	29°58'34.27"N	39°49'52.23"E
6	Settlement – small isolated farm plot with attached operational orchard	29°57'48.81"N	39°46'10.82"E
7	Settlement - small isolated farm plot with attached orchard	29°55'48.00"N	39°56'43.00"E
8	Settlement 1 (Seasonal Herders)	30° 1'59.46"N	39°55'4.31"E
9	Settlement 2 (Seasonal Herders)	30° 1'26.50"N	39°54'30.73"E
10	Farms – small isolated cluster of outbuildings with small patch of agriculture.	29°57'57.32"N	39° 54'54.57"E
1	Al Jouf International Airport	29°47'4.18"N	40° 6'3.97"E
2	Al Jouf Technical College	29°46'34.31"N	40° 1'26.58"E
3	Al Jouf University	29°47'12.09"N	40° 2'42.06"E
4	Operational gypsum quarry	30° 0'26.41"N	39°54'57.69"E
5	Proposed New MODON Industrial City for Women	29°46'15.78"N	39°58'56.71"E
6	Saudi Electricity Company Sub-Station	29°46'32.11"N	40° 0'42.68"E
7	Saudi Electricity Company Power Plant	29°46'32.11"N	40° 0'42.68"E
8	Saudi Aramco Bulk Plant	29°49'49.10"N	40°10'32.66"E
9	Social Housing Development Project	29°48'44.59"N	40° 12'37.00"E

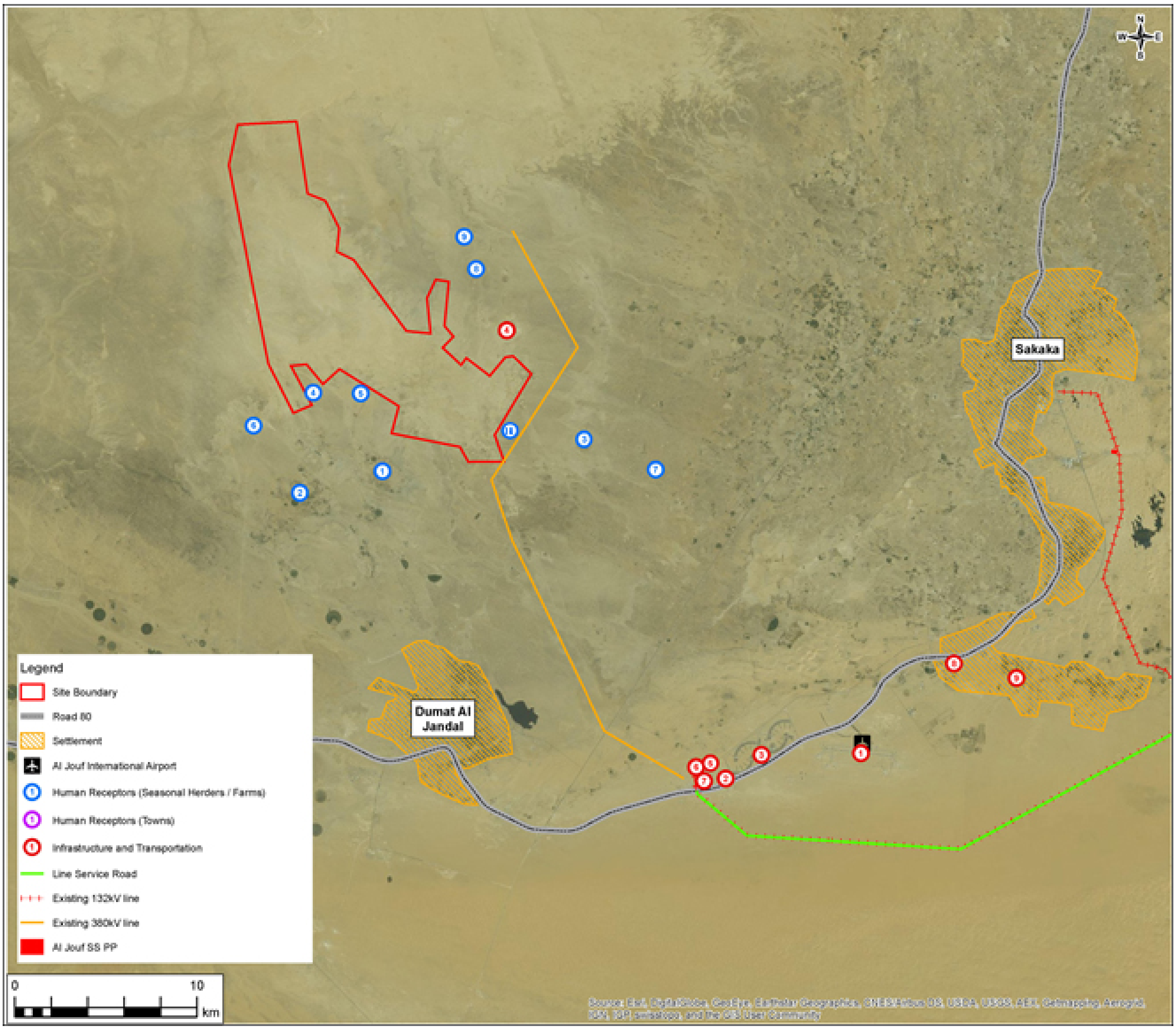


Figure 4-14: Location of Human Receptors

4.7.1.4 Mobile Telecommunications

There are two mobile telecommunication masts located near the development site. These are operated by Mobily and Zain, and are located approximately 5 km south west of the development site.

4.7.2 Future Development

4.7.2.1 Expansion of Overhead Power Lines

The SEC is currently installing a new 380 kV overhead power line, to the east of the Park which connects to the Al Jouf Power Plant. At this stage it is unclear whether the Park will be able to connect into this infrastructure, or indeed where the new overhead transmission line will terminate.

4.7.2.2 Expansion of Quarry

The licensed boundary of the gypsum quarry is unknown, and at this stage it is unknown whether plans exist to expand the existing quarry further towards the site boundary. There are no other known plans for development within the boundary of the development site or in close proximity to its boundary.

4.8 Project Schedule

Construction of the Park is expected to start in Q2 2018 and will take approximately 20 months. The Park will be in operation for 25 years.

4.9 Workforce and Number of Employees

The Park is expected to create 600 person years of construction work and 80 operations and maintenance jobs. In order to construct the first phase of the Park in the allocated 20 month timeframe, 180 workers will be required per phase.

There will be no permanent site-based workforce during the operational phase. The operational staff will be distributed throughout existing offices which are remote to the project site. Maintenance and security staff will visit the site periodically but there will be no permanent site presence.

4.10 Construction Phase

4.10.1 Pre-Construction Activities

Prior to the installation of the Wind Turbine Generators (WTG), the project site will require civil works including site clearance, grading and the preparation of foundations. The site exhibits comparatively uniform topography and the WTG and major infrastructure will be located outside of the wadi areas. For this reason, civil works will primarily be restricted to the alignment of the internal access roads which will run between the WTG, and preparation of the WTG foundations and the compacted crane pads for heavy lifting equipment. These crane pads will be used during the installation, maintenance and future decommissioning of the WTG. Localized site preparation will also be undertaken for the 33 kV switching stations.

Pre-Construction activities are expected to include the following:

- Construction of access roads;
- Grading and levelling of the development site to prepare for the construction of foundations;
- Excavation of cable trenches and other ground works required to install electrical infrastructure; and,
- Installation of developer compound and associated temporary infrastructure.

The following raw materials are expected to be utilized during the pre-construction phase of the Park.

Table 4-2: Estimated Pre-Construction Materials

Item		Unit	Quantity (Approx.)
Temporary construction site offices / buildings	Asphalt Road Surface	m^3	50
	Aggregate Sub-base for Roads	m^3	100
	Aggregate Base for Roads	m^3	50
	Fencing	m	6600
	Modular Accommodation Blocks	No.	45
	Modular Office Block	No.	1
General Site Preparation	Gravel Base for Un-sealed Roads	m^3	62,450
	Gravel Base for Crane Pads	m^3	29,700

4.10.1.1 Main Construction Phase

4.10.2 Temporary Facilities

The preliminary design on which the ESIA is based does not include a Constructability Plan. However the proposed dimensions of the construction compounds are 50 m x 100 m and are located in close proximity to site access roads. The temporary construction camp will provide accommodations for an estimated 180 workers on site during the construction phase simultaneously.

While the construction camp is yet to be designed, it will be provided in accordance with the IFC EHS General EHS Guidelines for Occupational Health and Safety, which provide guidance on the layout, facilities and conditions of construction camps. . The construction camp is anticipated to include site offices and associated facilities, and accommodation. Communal facilities proposed for the camp include:

- Recreation area;
- Kitchens and dining halls;
- Laundry;
- First aid facilities; and,
- Mosque.

4.10.3 Construction Materials

At this stage of the development, the quantities of construction materials have not yet been calculated. However an estimate of the principal construction materials has been developed based on the preliminary engineering design (Table 4-3).

Table 4-3: Estimated Construction Materials

Item		Unit	Quantity (Approx.)
Substation Construction	Asphalt for Access Roads	m^3	30
	Base Course for Access Roads	m^3	30
	Sub Base for Access Roads	m^3	60
	Generators	No.	4
	Transformers	No.	4
	Concrete Masonry Units	No.	4800
	Concrete for Building Plinths	m^3	428
Construction of Wind Turbines	Concrete for floating foundations	m^3	60,720
	Steel reinforcement bars	ton	6070
	Engineering fill for turbines	m^3	10560
	300 mm copper conductor cable	m	76,555
	630 mm copper conductor cable	m	60,845
	Communications Cables	m	103,730
	Turbine Towers (Delivered in three sections)	No.	132
	Nacelles (Including mechanical elements)	No.	132
	Blades	No.	396
	Self-Building Crane	No.	3

Item		Unit	Quantity (Approx.)
	Fencing (50 m per turbine)	m	6600

4.10.4 Construction Utilities

4.10.4.1 Water

There is no installed water supply within or adjacent to the developable area of the Park and the demand for water during the construction phase will be met by imported supplies.

The estimated water requirement of the construction workforce is based on an average per person per day water usage of 0.325 m^3, based on Saudi Aramco Engineering Standard SAES-A-104. The construction workforce is expected to comprise of approximately 180 persons, and therefore, the daily water requirement for the construction camp is expected to be approximately 58.5 m^3 per day. This water will be supplied by water tanker.

Potable water will be supplied by tanker for use by personnel at the construction compound. It is estimated that 3 liters /person/day of potable water will be required. As such an average of 5.4 m^3 of potable water per day will be required during the construction period. This water will be supplied by water tanker.

A dry mix batching plant will be located on site, and water will be brought to the project site by tanker for concrete production. It is estimated that approximately 21,252 m^3 of water will be required (i.e. approximately 483 vehicle movements).

All water storage and discharge systems to be used during the construction phase of the Park including washout of concrete mixing areas, disposal of wastewater and on site storage will be designed during the next phase of the development and will be in compliance with IFC EHS Guidelines: Environmental 1.3 Wastewater and Ambient Water Quality and the IFC Environmental, Health, and Safety Guidelines for Water and Sanitation.

4.10.4.2 Power

There is no installed power supply within or adjacent to the developable area of the Park, and the demand for power during the construction phase will be met by diesel powered generators.

Power at the construction camp will be provided by two 500 kw diesel fueled generators running for 720 hours per month each. A further standby generator will be present on site, although this is not expected to be operational unless required. There is no intention at present to supply direct power from the SEC 13.8 kV power line although this is an option to be considered during the next phase of development.

Based on an average consumption of 33 gallons of diesel fuel per 24 hour period, an average running utilization rate of 1,000 gallons per generator per month is estimated. These figures are based on conservative estimates of fuel utilization and do not account for summer cooling of buildings and other uses which may place additional demand upon the generators.

Diesel fuel for power generation will be stored in accordance with Section 1.5 of the IFC General EHS Guidelines, in particular the guidelines for secondary containment. The guidelines state that appropriate secondary containment structures for above ground tanks consist of berms, dikes or walls capable of containing the larger of 110 % of the largest tank or 25 % of the combined tank volumes in areas with above-ground tanks with a total storage volume equal or greater than 1,000 liters.

Generators used will be selected and supplied according to the requirements of IFC Environmental Health and Safety Guidelines 1.1 *Air Emissions and Ambient Air Quality* and GAME Environmental Standards for air emissions from stationary sources (2012).

4.10.4.3 Vehicle Re-Fueling and Fuel Storage

Construction vehicles will largely be diesel fueled. Re-fueling of vehicles will take place at designated areas where fuel will be stored in 60 m^3 110 % double bunded containers or similar as specified in the relevant standards. The vehicle re-fueling and storage areas will be located in close proximity to the developer compounds and will be designed in compliance with IFC EHS Guidelines 4.0: *Construction and Decommissioning.*

This includes the following requirements:

- Providing adequate secondary containment for fuel storage tanks and for the temporary storage of other fluids such as lubricating oils and hydraulic fluids;
- Using impervious surfaces for refueling areas and other fluid transfer areas;
- Training workers on the correct transfer and handling of fuels and chemicals and the response to spills;
- Providing portable spill containment and clean-up equipment on site and training in the equipment deployment;
- Assessing the contents of hazardous materials and petroleum-based products in building systems (e.g. PCB containing electrical equipment, asbestos-containing building materials) and process equipment and removing them prior to initiation of decommissioning activities, and managing their treatment and disposal according to Sections 1.5 and 1.6 on Hazardous Materials and Hazardous Waste Management, respectively; and,
- Assessing the presence of hazardous substances in or on building materials (e.g., polychlorinated biphenyls, asbestos containing flooring or insulation) and decontaminating or properly managing contaminated building materials Construction Wastes.

A Construction Site Waste Management Plan (CWMP) will be prepared, in compliance with regulations and best practice, and implemented by the Contractor before the production of any waste material. This plan will identify in detail the types and volumes of waste and how this waste will be handled, stored, managed, treated, disposed of and controlled. The requirements for this CWMP are addressed in the outline Environmental Management and Monitoring Plan.

Suitably qualified and accredited sub-contractors will be used during the removal and transportation of hazardous materials. All records for the transportation and disposal of hazardous waste will be maintained (and kept available for random inspection) on site.

Where hard surfaces have the potential to collect fluids such as diesel, lubricants or other construction fluids (e.g. car parks and vehicle maintenance areas), oil interceptors will be utilized as per the requirements of GAME Environmental Standard 6 - *Storage and Material Reclaim Facilities Design and Operation.* This will prevent the introduction of any harmful fluids into the environmental resources of the development site.

4.10.4.4 Wastewater

There is no installed sanitary or wastewater network within or adjacent to the developable area of the Park, and the requirements for wastewater disposal will be met by on-site storage and disposal via suction tanker. Sanitary waste is expected to be generated at a rate of 0.325 m^3 per person per day, based on Saudi Aramco Engineering Standard SAES-A-104. It is anticipated therefore that approximately 58.5 m^3 of sanitary waste will be generated on-site each day.

Sanitary waste will be stored in underground septic tanks and collected by suction tankers for local disposal. The design of the storage facilities will be compliant with IFC EHS Guidelines 1.3 Wastewater and Ambient Water Quality and disposal standards and IFC EHS Guidelines for Water and Sanitation.

4.10.4.5 Traffic and Logistics

On average 16 vehicle movements per day will be required in order to bring all of the required construction materials to the development site and construct the first phase of the Park. This will include a combination of dumper trucks, concrete mixing trucks, water tankers and HGVs.

Traffic will be managed in accordance with best practice recommendations laid out in IFC EHS Guidelines 3.0 *Community Health and Safety* and IFC EHS Guidelines 4.0: *Construction and Decommissioning*.

The route of entry to the Kingdom of Saudi Arabia which the wind turbines will utilize is currently unknown. It has been assumed for the purposes of this assessment that turbines would be transported via sea, and would enter the Kingdom of Saudi Arabia via the Jubail Port in the Eastern Province. The delivery schedule and logistical arrangements proposed for the transport of the turbine components to the development site, is unknown at this stage of the development. It is possible that the turbine components could be transported in convoy from the point of entry into the Kingdom of Saudi Arabia to the development site following temporary storage at the Port. It is anticipated that convoys would form up to five vehicles and be accompanied by Police escort. As an exceptional load, the transport of turbines will require a permit issued by the Ministry of Transport.

Table 4-4: Delivery Requirements and Vehicle Capacities

Delivery Item	Material Quantity	Vehicle	Vehicle Capacity	Number of Vehicles Required	Notes/Assumptions
Turbine Towers	396 no.	Low Loader	1 section per loader	396	Three sections per turbine tower
Nacelle	132 no.	Low Loader	1 nacelle per loader	132	1 nacelle per turbine
Blades	396 no.	Low Loader	1 blade per loader	396	Three blades per turbine
Gravel	102,950 m^3	Dumper Truck	32 ton	4820	Deliveries of gravel for sub base, fill material etc.
Asphalt	80 m^3	Dumper Truck	32 ton	2	
Fencing	6600 m	HGV	100 rolls per vehicle	3	Fencing delivered in rolls of 25 m.
Dry Mix Cement	39,468 m^3	Flat Bed Truck	14 x 1 ton bags per truck	2800	
Water for Concrete Production	21,250 m^3	Water Tanker	44 m^3	480 m^3	
Cables	261,590 m	Low Loader	4 cable drums per low loader.	131	Four cable drums per low loader – 500 m of cable per drum
Reinforced Steel Bar	6072 ton	Flat Bed Truck	20 ton	304	Standard Flatbed trucks with 20 t capacity.

Table 4-5 shows the plant items anticipated to be required during the construction phase of the Park, and the estimated daily hours of operation.

Table 4-5: Construction Plant and Equipment

Activity	Plant Item	No.	Description	Est. Hrs of operation per day
Site installation - laydown area – grading – construction compound etc.	Asphalt Pavers	1	4.5 l engine	10
	Roller Vibrator	4	6.75 l engine	10
	Bulldozers	4	6.7 l engine	10
	Rolling/Vibrating Compactor	4	3.4 l engine	10

Activity	Plant Item	No.	Description	Est. Hrs of operation per day
	Road Planer	4	5.9 l engine	10
	Road Wagons	4	11.2 l engine	10
	Grader	4	10.3 l engine	10
	Dust Suppression (Water Truck)	2	10 l engine, 5-10,000 gallon capacity	10
Installation of wind turbine generators and infrastructure (foundations, cabling, power supply etc.)	Crane	3	Self-building capability for erecting turbine towers and installing nacelle/blades.	
	Excavator	10	12 l engine	10
	Trailer Pump	10	9 l engine	10
	Concrete Mixer Truck	10	10.5 l engine – 6 m3 capacity	10
	Flat Bed Truck	10	6 l engine- to be used across all activities for general site deliveries and other purposes	10
	Hand Operated Tools	10	Drills, power tools, saws etc.	10
	Telescopic 4wd Fork Lift	1	7 l engine	10
	Mini Excavator	1	2.3 l engine	10
	Trenching Machine	10	0.5 l engine, 3 m wide trench.	10
	Cable Drum Trailer	10	Standard cable drum – wooden construction.	
	HV Test Equipment Truck	10	Standard test equipment truck.	
	Generators	4	500 kV generators to be used at site compound	24
	Dump Truck	2	10.5 l engine – 32 t capacity	10
Site Operation	4wd Utility vehicles	10	General site management vehicles	10
Decommissioning	Telescopic 4WD Forklift	10		
	Crane	3	Self-building capability for erecting turbine towers and installing nacelle/blades.	10
	Flat Bed Truck	10		
	Hand Operated Tools	100		
	Pneumatic Drills and Jackhammers	50		
	Excavator	10	12 l engine	
	Dump Trucks	50	11.2 l engine – for moving spoil material off site.	

4.10.4.6 Waste Generation

A Construction Site Waste Management Plan (CWMP) will be prepared, in compliance with regulations and best practice, and implemented by the Contractor before the production of any waste material. This plan will identify in detail the types and volumes of waste and how this waste will be handled, stored, managed, treated, disposed of and controlled. The requirements for this CWMP are addressed in the outline Environmental Management and Monitoring Plan.

Suitably qualified and accredited sub-contractors will be used during the removal and transportation of hazardous materials. All records for the transportation and disposal of hazardous waste will be maintained (and kept available for random inspection) on site.

Solid waste includes office consumables and other general waste. It is anticipated that this waste will be generated at a rate of 1.1 kg per person per day as per World Bank Standards (World Bank, 2012). This would result in a total of 396 kg of waste being generated at the development site each day.

The estimated quantities of waste generated during the construction phase of the project are listed in Table 4.6.

Table 4.6: Estimated Construction Wastes

Waste type	Source	Classification	Estimated Quantity (t)	Destination
Inert soils, sand, rocks	Spoil from grading activities and other inert rock materials requiring removal from site.	Inert	10	Stored on site and reinstated following decommissioning
Residual construction material e.g. brick, ceramics etc.	Residual materials from construction of construction compound, O&M buildings.	Non-haz	5	Class II Landfill
Scrap Metal	Off cuts from building construction.	Non-haz	4	Class II Landfill
Scrap Metal	Off cuts from fencing.	Non-haz	2	Class II Landfill/ Recycling
Residual construction materials e.g. bolts, rebar etc.	Construction of turbine foundations and assembly of turbines.	Non-haz	10	Class II Landfill
Excess Cables	Power Transmission Cables	Non-Haz	10	Class II Landfill/ Recycling
Plastic Bottles, cans, food waste, paper etc.	Site office & Canteen waste	Non-haz	140	Class II Landfill/Recycling
Paper, Cardboard & Plastic Packaging	Materials packaging	Non-haz		Class II Landfill/Recycling
Waste Electrical & Electronic Equipment	Residual materials from installation of electrical equipment	Haz	1	Recovery/Class I Landfill
Residual construction material e.g. plaster & cement	Residual materials from construction of compounds	Haz	1	Class I Landfill
Oil contaminated wastes	Construction vehicle maintenance	Haz (liquid)	0.1	Recovery/Class I Landfill
Asphalt	Site access road	Haz	1	Class I Landfill
Paint, thinners, contaminated painting equipment, solvents etc.	Residual materials from construction of construction compounds.	Haz (liquid)	0.1	Class I Landfill
		Total Hazardous Solid Waste	3 (rounded)	
		Total Hazardous Liquid Waste	0.2 (rounded)	
		Total Non-hazardous Solid Waste	181	

The waste receiving site to the project site is located approximately 65 km to the south-east of the Park. The site is owned by the Ministry of Municipal and Rural Affairs and operated by Saraya Al Jazera Contracting Company. The landfill serves Sakaka and the neighboring villages and is comprised of two areas. The first area is currently in operation and covers an area of 2,000,000 m^2 and only 2 % of capacity has been utilized. The second area covers an area of 750,000 m^2 and has 100 % capacity available (i.e. it has not yet been put into operation).

The facility receives municipal waste, construction waste, green waste (e.g. tree cuttings etc.) and liquid waste from abattoirs. Daily, the facility receives approximately 450 tons of municipal waste, 180 tons of solid waste including construction waste and debris. No waste segregation or recycling is undertaken.

The landfill is not engineered and waste is placed within designated cells (100 m x 25 m) to a height of 1 m and then covered with 0.3 m of sand. This layer is then compacted using a bull dozer. Subsequent layers are filled on top of each other in the same manner until approximately 6-8 layers have been compacted.

Liquid waste from the abattoir is put into a 4 m deep pit with sodium hydroxide and then buried with sand to prevent odors.

Based on the data provided by the Ministry of Municipal and Rural Affairs there is capacity within this facility to receive construction waste from the project.

4.11 Operation Phase

4.11.1 Operation Phase Activities

Wind Energy will be generated at the Dumat Al Jandal Wind Energy Park using automated infrastructure. There is currently no intention for full time staff to be located at the Park, as all monitoring will be carried out by staff in remote locations.

There will be intermittent maintenance and inspection teams visiting the facility, but these teams will not be permanently based at the Park.

4.11.2 Operation Utilities

4.11.2.1 Water

The operational workforce for the Park is estimated to be 80 people; however these will be distributed within existing offices remote to the Park (i.e. SEC, Saudi Aramco, MEIM, technology supplier). There will be no permanent operational workforce based at the Park and therefore there will be minimal requirement for water during the operational phase of the Park.

The sub-stations will be provided with a 500 gallon water tank for toilets and sinks, and bottled drinking water will be supplied separately.

4.11.2.2 Power

An SEC collector sub-station shall be built by SEC as outlined in the Memorandum of Understanding between Saudi Aramco and SEC. The SEC collector sub-station shall comply with the requirements of the IFC EHS Guidelines for Electric Power Transmission and Distribution, and will provide the required auxiliary supply for power plant energy consumption. The location of the SEC collector sub-station will be identified during the next phase of development, but it will preferably be located in close proximity to one of the 33 kV HV switching stations.

A backup diesel generator will be installed to provide power in case of network failure. The generator will comply with the IFC General EHS Guidelines Section *Hazardous Materials Management*.

4.11.2.3 Vehicle Refueling and Fuel Storage

It is not anticipated that there is any requirement for on-site vehicle refueling facilities, including the storage of vehicle fuel. The vehicles on site will primarily be road vehicles and these will be filled from local service stations.

A diesel fuel tank will be installed to store diesel fuel for the on-site diesel generator. The storage of fuel will comply with the IFC General EHS Guidelines Section *Hazardous Materials Management*.

4.11.2.4 Sanitary Waste

There will be no permanent operational workforce based at the Park and therefore there will be minimal requirement for sanitary waste water management during the operational phase of the Park. It is proposed to install a PVC septic tank with capacity for 5 persons associated with the sub-station buildings, although sanitary waste generation will be intermittent.

Sanitary waste will be stored in the underground septic tanks and collected by suction tankers for local disposal. The design of the storage facilities will be compliant with IFC EHS Guidelines 1.3 Wastewater and Ambient Water Quality and disposal standards and the IFC EHS for Water and Sanitation.

4.11.2.5 Traffic and Logistics

There will be no permanent operational workforce based at the Park and therefore there will be no vehicles permanently based at the Park. Traffic movements to and from the Park will be intermittent, and primarily associated with maintenance and inspection teams visiting the Park.

Maintenance will be carried out periodically at the site using 4x4 maintenance vehicles. Maintenance activities will typically involve the checking and occasional repair of turbine monitoring and metering equipment. A mechanical failure of any of the wind turbine machinery such as braking or power generation equipment would rapidly escalate into an emergency scenario and as such, any repairs of this nature would not be considered to be routine maintenance.

4.11.2.6 Waste Generation

There will be no permanent operational workforce based at the Park and therefore there will be minimal waste generation during the operational phase of the Park.

4.12 Ongoing Design Optimization

During the next phase of the development, there will be a requirement to refine the construction materials and equipment utilized in the construction of the Park in order to integrate the principles of cleaner production as specified in IFC Performance Standard 3. This standard requires the investigation of financially feasible options for all resources.

Any changes to the description presented in this chapter, will be reflected in an addendum to this ESIA, to be prepared by the IPP during the next phase of development.

The objective of this requirement is to promote the conservation of resources and the minimization of impacts associated with construction of infrastructure. During the detailed design phase of the Park, continuous improvement in design should be pursued in order to ensure that energy and resource efficiencies are identified and integrated into the design of the Park wherever possible.

4.13 References

AECOM (2016). Dumat Al Jandal Wind Farm Development *Hydrology and Flood Risk Assessment Phase 2 Report - FINAL*

Arab Company for Laboratories and Soil (2017) Detailed Geotechnical Site Investigation for Dumat Al Jandal Wind Farm (CSD 2014_98A) Al Jouf Province - KSA

DNVL GL- Energy. (2017a). *Dumat Al Jandal Preliminary Design Assessment*

DNVL GL- Energy. (2017b). *Dumat Al Jandal Energy Yield Assessment*

(https://www.siemens.com.tr/i/Assets/brosurler/OrtaGerilimveAlcakGerilimEnerji/brochure-connecting-wind-power-to-the-grid_en.pdf)

5. Impact Assessment Methodology

5.1 Introduction

This chapter presents an overview of the methodology applied to the assessment of potential environmental and social impacts arising from the proposed construction, operation and decommissioning phases of the Dumat al Jandal wind energy park.

The impact assessment criteria outlined in the following sub-sections have been applied to the assessment of each of the proposed project elements, taking into account the construction, operation and decommissioning phases of the development. Where specific methods of assessment are to be applied and which deviate from the approach described in this section, these will be presented in the relevant sections of the ESIA. For ease of referencing, a unique identification code (ID) is used to refer to each impact. For instance, impacts associated with Air Quality are coded as AQ1, AQ2, etc.

The technical scope of this Environmental and Social Impact Assessment (ESIA) is comprised of four stages, which are listed below:

- Description of the environmental baseline, including identification of potential receptors and their sensitivity to change.
- Prediction of environmental impacts, characterization of environmental impacts and the assessment of likely magnitude of change upon receptors.
- Assessment of impact significance.
- Environmental mitigation, compensation and enhancement.

In the Kingdom of Saudi Arabia, key principles provided by GERRI (2001) provide a basis for assessing environmental impacts. The GERRI Key Principles are as follows:

- Nature and magnitude of the intended activity and the existence of similar projects at the site or similar sites.
- Extent of depletion by the installation of the natural resources, particularly agricultural lands and mineral resources.
- Location of the installation and the nature of the surrounding environment and nearby residential clusters.
- Type of power used.

The approach to the assessment of environmental impact has fully considered the criteria of the GAME and Saudi Aramco's Engineering Procedure for Project Environmental Impact Assessments (SAEP-13), in addition the requirements of the lending bodies (i.e. World Bank and IFC).

Construction of the Park will be implemented in phases. For the purposes of this report, the Park has been assessed as a whole.

5.2 Establishment of Baseline Conditions and Receptor Identification

The environmental baseline on which the assessment of impact has been established using desk based studies, literature reviews and reviews of current reports, field visits and analysis of monitoring data.

Site visits were carried out by qualified Environmental Engineers between the dates shown below:

- 11th December 2016 to 14th December 2016.
- 27th January 2017 to 30th January 2017.
- 12th March 2017 to 2nd May 2017.

Stakeholder consultation has commenced, however, the process is ongoing. Further consultation will be required, and will be carried out by the IPP during the next phase of development.

An initial evaluation of sensitivity of baseline environmental aspects has been determined using the findings of the literature review and field work, and the professional experience of Jacob's environmental impact evaluators. The general definitions of sensitivity that have been used are described in Table 5-1 below.

Table 5-1: Sensitivity of receptors

Sensitivity of Receptor	Description
High	An unmodified natural environment with high levels of healthy life that may include 'protected areas' (or be of an equivalent standard to such areas) or 'protected species'. Areas where humans exist for extended periods in particular vulnerable groups. Examples include residences, schools, hospitals and places of worship.
Moderate	A natural environment subject to some adverse impacts from human or natural causes but still with high levels of healthy life. Although a valuable environment, it is not classed as a protected area. Areas where humans exist for lesser periods including commercial and leisure areas. Places of work are also considered moderate as it is assumed that those at work are not the vulnerable (old, young, infirm).
Low	A natural environment which has already been substantially affected in some form by either human influences or natural events. Ecological life is sparse or impacted by various pressures. Areas that humans exist transiently such as large roads.
Negligible	Heavily impacted natural environment and/or low species presence & diversity. Areas that have little human activity.

5.3 Prediction of Environmental Impacts

Environmental impacts are the changes to baseline conditions which occur as a direct result of the development. The assessment of impact accounts for natural change that might reasonably be predicted in the absence of the development ("the do-nothing alternative").

Predicting the effects of a development is a fundamental stage in ESIA, which allows the significance of impacts to be determined.

The predicted environmental and social impacts of the development have been characterized using the criteria in Table 5-2 in order to ensure objectivity in the assessment process.

Table 5-2: Impact Characterization

Category	Terminology	Definition
Type of Impact		
Impact	Positive	Beneficial Impact
	Negative	Adverse impact
Action	Direct	Impact caused solely by activities within scope of project.
	Indirect	Impact which does not result directly from activities within the scope of the project, but which has a connection with the project.
Probability of Impact		
Likelihood	Certain	Impact possibility estimated to be 100 %
	Likely	Impact possibility estimated as between 50 % and 99 %
	Unlikely	Impact possibility estimated as < 50 %

Category	Terminology	Definition
	No impact	Zero estimated possibility of impact
Frequency	Continuous	Uninterrupted or on a daily basis
	Frequent	Once or more per day
	Infrequent	Less than once per day
	Rare	Single event / less than once per year
Consequence of Impact		
Duration	Short	Less than the life of project
	Medium	The life of the project
	Long	Greater than the life of project
Extent	Local	Within 2 km of the Project Site boundary
	Provincial	Outside the Project Site boundary, but <20 km away
	Regional	Outside the Project Site boundary, but < 200 km away
	National	Within KSA
	International	Outside KSA
Permanence	Reversible	Impact is not permanent and change is reversible
	Irreversible	Impact is permanent and cannot be reversed

Considering the above criteria, magnitude of change can be described in absolute terms. The general criteria used for describing impact magnitude are included in Table 5-3. The application of these criteria enables the type, probability and consequence of each predicted impact to be described and categorized.

Table 5-3: Magnitude of Impact

Impact Magnitude	Description
High	An accepted limit or standard may be exceeded or significant or permanent degradation/adverse alteration to resource/receptor.
Moderate	An effect within accepted limits and standards. Moderate degradation/ adverse alteration to resource/receptor. Moderate impacts may cover a broad range, from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit.
Low	An effect will be experienced, but the magnitude is small and well within accepted standards. Minor degradation/ adverse alteration to resources/receptor.
Negligible	A resource or receptor will not be affected in any way by a particular activity or the predicted effect is deemed to be 'negligible' or indistinguishable from natural background variations

The significance of the predicted environmental impact takes account of the sensitivity or the importance of the baseline aspect subject to change, and the type, probability and the consequence of the impact and the magnitude of the potential impact.

A table can be prepared; combining information on the sensitivity of the receptor with the information about the magnitude of impact. Combining the two sets of analysis, from Table 5-2 and Table 5-3, enables a simple matrix of significance to be compiled, as shown in Table 5-4. The definitions of significance are given in Table 5-5.

Table 5-4: Significance of Impact

Magnitude	Sensitivity			
	High	**Moderate**	**Low**	**Negligible**
High	High	High	Moderate	Negligible

Magnitude	Sensitivity			
	High	**Moderate**	**Low**	**Negligible**
Moderate	High	Moderate	Low	Negligible
Low	Moderate	Low	Low	Negligible
Negligible	Low	Negligible	Negligible	Negligible

Table 5-5: Definition of Significance

Significance	Description
High	Any high magnitude impact that is certain or likely to occur and of medium or long duration, and regional in extent.
Moderate	Any moderate magnitude impact that is certain or likely to occur and of medium or long duration. Also any high magnitude impact that is unlikely to occur of short duration or local in extent.
Low	Any low magnitude impact or medium magnitude impact that is unlikely to occur or is of short duration.

5.4 Impact Assessment Reporting

The findings of the assessment process for each environmental aspect have been presented as indicated in Table 5-6. The ID codes assigned to each impact are used to reference the impacts and associated mitigation measures throughout the chapters of the ESIA.

Table 5-6: Example of Impact Assessment Summaries

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
AQ1	*Faculty, staff and students*	*High*	*Potential dust inhalation/ nuisance resulting from construction activities.*	*Effect: Negative* *Action: Direct* *Likelihood: Likely* *Frequency: Frequent* *Duration: Short* *Extent: Local* *Permanence: Reversible*	*Moderate*	*Moderate*

5.5 Mitigation Measures and Reporting

5.5.1 Approach to Mitigation

The environmental assessment process requires the ESIA to recommend measures in order to avoid, reduce and remedy significant adverse environmental impacts. Development impacts which are identified as being of moderate to high significance are assessed against appropriate mitigation measures, to predict the residual impact significance. An example of the table used to report the mitigation identified for impacts of moderate to high significance is shown in Table 5-7.

Table 5-7: Example of Impact and Mitigation Summaries

ID	Potential Significance	Mitigation Measures	Residual Significance

Mitigation measures and recommendations identified in this ESIA report to manage potential impacts can be categorized as:

- Primary: Measures to be taken to manage potential impacts considered to be of moderate or high significance. Following the application of these measures, residual impacts are expected to be lowered.
- Secondary: Recommended measures that could be taken to manage impacts classified as low/insignificant. These measures can be considered as good management practices.

The approach to mitigation has adopted the mitigation hierarchy whereby priority has been given to avoiding / preventing adverse effects and then minimization of impacts through the identification of appropriate abatement / mitigation measures. For impacts which cannot be adequately mitigated, restoration or reinstatement might be required to address temporary construction effects. In the cases of the permanent loss of a feature, compensation might be required. The mitigation hierarchy is illustrated in Figure 5-1 : Mitigation Hierarchy.

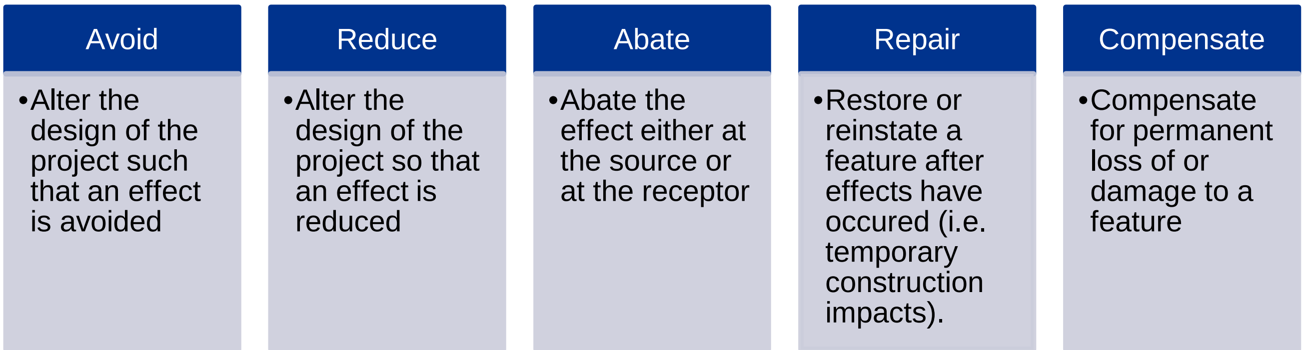


Figure 5-1 : Mitigation Hierarchy

5.6 Conclusion

The methodology applied to this ESIA defines appropriate mitigation measures for expected impacts, giving preference to the avoidance of impacts. This is achieved initially through the examination and analysis of alternatives, design or operational processes, and then by outlining alternative ways identified for mitigating any predicted environmental and social impacts.

6. Meteorology, Climate & Air Quality

6.1 Introduction

This Chapter presents a summary of the meteorological conditions and the existing ambient air quality in the vicinity of the Dumat Al Jandal Wind Energy Park (referred to hereafter as the Park) site and the prediction of potential air quality impacts from construction dust and greenhouse gases (GHG) resulting from the various stages of the development. The phases considered in this assessment include construction, operations, and decommissioning.

6.2 International and National Standards and Guidance

6.2.1 International Conventions

The Kingdom of Saudi Arabia cooperates internationally to protect and manage the environment, and participates in the work of codification of international environmental law. This commitment is manifested in the signing and ratification of the following International and Regional conventions on the environment.

The agreements are a very important legal instrument for the environment. For example, Principle 17 of The 1992 Rio Declaration on Environment and Development states that *'Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.'* For further information regarding conventions that the Kingdom of Saudi Arabia is signatory to, see chapter 2 *Policy & Legal Framework*.

The relevant International Agreements and Conventions of potential significance to the Park are:

- 1985 Vienna Convention for the protection of the ozone layer, Vienna;
- 1987 Montreal Protocol on substances that deplete the ozone layer and its Amendments (1990 and 1992);
- 1991 The Arab Declaration on Environment and Development;
- 1992 Agenda 21 and the Rio Declaration on Environment and Development;
- 1992 UN Framework Convention on Climatic Change (UNFCCC), New York;
- 1997 Kyoto Protocol to the UN Framework Convention on Climate Change, Kyoto;
- 2005 Kyoto Protocol to the UN Framework Convention on Climate Change, ratified in 2005; and,
- 2016 Paris Agreement to the UN Framework Convention on Climate Change, ratified in 2016.

According to the Kingdom of Saudi Arabia's Intended Nationally Determined Contribution (INDC) under the UNFCCC, Saudi Arabia is aiming to annually abate up to 130 million tons CO_2 Equivalent ($MtCO_2e$) by 2030 through contributions that have co-benefits in diversifying the economy and mitigating GHG emissions. Some of the plans to meet this target include improved energy efficiency, use of renewable energy, increasing the use of gas and methane recovery and flare minimization (INDC, 2015).

6.2.2 IFC (World Bank Group) EHS Guidelines (2012)

The IFC EHS *Guidelines for Air Emissions and Ambient Air Quality* (2007) establish ambient air quality limits and guidelines for projects with significant sources of air emissions and potential for significant impacts to ambient air quality. Projects with emissions should not result in pollutant concentrations that reach or exceed relevant ambient air quality guidelines and standards by applying national legislated standards, or in their absence, the current World Health Organization (WHO) Ambient Air Quality Guidelines. In this instance national legislated standards are those implemented by the General Authority for Meteorology and Environment (GAME). Furthermore, emissions should not contribute to a significant portion to the attainment of relevant ambient air quality guidelines or standards (IFC, 2007).

The WHO ambient air quality guidelines are presented in Table 6-1.

Table 6-1: WHO and National Ambient Air Quality Standards

Pollutant	Averaging period	GAME (μg/m³)	WHO (μg/m³)
Sulfur Dioxide	10 Minute	-	500
	1 Hour	730	-
	24 Hour	365	20
	Annual	80	-
Nitrogen Dioxide	1 Hour	660	200
	Annual	100	40
Particulate Matter PM_{10}	24 Hour	340	50
	Annual	80	10
Particulate Matter $PM_{2.5}$	24 Hour	35	25
	Annual	15	10
Ozone	8 Hour	157	100
Carbon Monoxide	1 Hour	40,000	-
	8 Hour	10,000	-

6.2.3 National Standards

6.2.3.1 General Authority for Meteorology and Environment (GAME)

GAME, formerly the Presidency of Meteorology and Environment (PME), is the competent authority for environmental regulation in Saudi Arabia and is responsible for the general regulatory framework for the development and enforcement of environmental rules and regulations. Appendix 1 of the GAME's General Environmental Regulations and Rules for Implementation 2001 (GERRI, 2001) outline the environmental protection standards relevant to facilities in the Kingdom of Saudi Arabia (EPSD-2001).

Ambient Air Quality

In 2012, the former PME developed a number of guidance environmental standards revising those enacted under GERRI in 2001. The ambient air quality standards for the Kingdom of Saudi Arabia are presented in Table 6-1. In accordance with the IFC EHS Guidelines (2007), local atmospheric and climatic conditions should be applied when considering air quality standards and guidelines. The standards for particulate matter for the Kingdom of Saudi Arabia have been tailored to reflect the regional context and naturally high levels of particulate matter, and accordingly are higher than the WHO standards. Whilst the WHO standard for PM_{10} is listed for reference, its achievement is unlikely.

Air Quality Standards for Emissions from Stationary Sources

Standards for emissions from stationary sources have been developed by GAME. These standards introduce emission limits for individual facilities, and assist in the protection of the Kingdom's public health, occupational health and natural ecosystems, including cropland, forest, desert and wetlands whilst allowing economic and social development (GAME, 2012). The standard obligates operators to apply effective process controls or best available pollution abatement techniques to meet emission limit criteria.

The standards cover industrial facilities, and emission standards for toxic, organic, carcinogenic, inorganic and volatile organic carbons are included. Those which are relevant to the project are presented in Table 6-2.

Table 6-2: Emission Limit Values for Emissions to Air from Stationary Sources

Pollutant	Emission Limit Values (µg/Nm^3)		Threshold (g/hr)	Comment
	A) Normal	B) Degraded Airshed		
Particulate Matter PM_{10}	150	100	500	Above background levels
Particulate Matter $PM_{2.5}$	50	25	100	Above background levels
SOx	600	400	1000	
NOx	500	350	1000	

As per the standard, in all circumstances, point source air emissions from any facility must not contain substances in concentrations that exceed the Normal Emission Limit Values as set out in Table 6-2. If a facility is within a degraded airshed the competent agency has the power to enforce all or some of Degraded Airshed Emission Limits set out in Table 6-2. These emission limit values are based on what is technologically feasible to achieve while not incurring excessive costs.

Air Quality Standards for Emissions from Mobile Sources

The GAME has set the framework and activities required to enable sustainable management of mobile source emissions within the Kingdom of Saudi Arabia. This standard introduces emission limits for individual pieces of equipment used outdoors and aims to protect, maintain and improve the Kingdom's quality of life, human health, occupational health and natural ecosystems including croplands, forests and deserts whilst maintaining appropriate economic and social development. This standard applies to construction equipment and plant that might be used during the construction and operation of a project, but does not apply to road vehicles.

This standard includes emission limits for diesel (compression-ignition) engines, small and large petrol (spark-ignition) engines, and other recreational vehicles not included in Saudi Standards, Metrology and Quality Organization (SASO) (GAME, 2012).

The standard requires that all owners or operators of non-road engines equipment and vehicles must ensure that they undertake appropriate emission-related maintenance. Emission-related maintenance includes any adjustment, cleaning, repair, or replacement of emission-related components, which include the following:

i. electronic control units, after treatment devices, fuel-metering components, EGR-system components, crankcase-ventilation valves, all components related to charge-air compression and cooling, and all sensors and actuators associated with any of these components; and

ii. any other component whose primary purpose is to reduce emissions (GAME, 2012).

This standard refers to air emissions from non-road engines, equipment and vehicles. This includes sources such as mobile generators and large earth-moving equipment (Table 6-3 and Table 6-4). This standard does not include emissions from road vehicles (GAME, 2012).

Table 6-3: Non-Road Petrol (Compression Ignition) Engines

Rated Power	CO (g/kW-hr)	HC (g/kW-hr)	NOx (g/kW-hr)	PM (g/kW-hr)	Smoke (%)
50≤ hp ≤100	n/a	n/a	9.25 (ABT)	n/a	20/15/50
100≤ hp ≤175	n/a	n/a	9.25 (ABT)	n/a	20/15/50
175≤ hp ≤750	11.4	1.34	9.25 (ABT)	0.54	20/15/50

Rated Power	CO (g/kW-hr)	HC (g/kW-hr)	NOx (g/kW-hr)	PM (g/kW-hr)	Smoke (%)
hp = 750+	11.4	1.34	9.25 (ABT)	0.54	20/15/50

Table 6-4: Non-Road Diesel (Spark Ignition Engines)

Rated Power	CO (g/kW-hr)	HC (g/kW-hr)	NOx (g/kW-hr)	HC + NOx (g/kW-hr)
<225 cc (non-handheld)	518.97	n/a	n/a	n/a
≥225 cc (non-handheld)	518.97	n/a	n/a	n/a
<20 cc (handheld)	804.6	295.02	5.36	0.54
≥20 cc >50 cc (handheld)	804.6	241.38	5.36	n/a
≥50 cc (handheld)	603.45	160.92	5.36	n/a

6.2.3.2 Saudi Standards, Metrology and Quality Organization

Although the GAME has established emission standards for the Kingdom of Saudi Arabia, emission standards for road vehicles are controlled by the Saudi Standards, Metrology and Quality Organization (SASO). In 2004, SASO adopted Euro 2 emissions standards for passenger cars with gasoline engines, and diesel powered light duty vehicles have been subject to standards based upon the EU legislation which was effective from 1984. The Kingdom of Saudi Arabia has previously proposed that Euro 3 standards would be implemented from 2010, but a lack of low sulfur fuel prevented this initiative from being implemented. The final date of the transition is still uncertain although the Kingdom of Saudi Arabia is implementing a national program to reduce the sulfur content of fuels.

6.2.4 Construction Dust Guidance

In the absence of guidance on construction dust impacts specific to the Kingdom of Saudi Arabia or the United States, the assessment of dust during construction has been carried out using a qualitative risk-based appraisal with reference to the sites location in relation to sensitive locations, the planned activities and site characteristics, as described by the UK specific Institute of Air Quality Management (IAQM) guidance (IAQM, 2016).

6.3 Baseline Conditions

6.3.1 Regional Meteorological Conditions

6.3.1.1 Overview

The GAME has confirmed the installation of a permanent meteorological station at Al Jouf airport. The meteorological data from this station was provided by the GAME and has been analyzed to characterize the meteorological conditions of the Dumat Al Jandal Wind Energy Park. This data-set provides continuous meteorological records for almost 40 years (i.e. 1978 to 2016). This data has been supplemented with the 2016 analysis of site-specific meteorological conditions undertaken using a ground measurement station.

6.3.1.2 Temperature

There is a large seasonal variation in monthly mean temperatures throughout the year. Mean temperatures range from 9.8^{o}C in the winter to 33.1^{o}C in the summer. The data showed that Al Jouf's hottest months are June–August, and the coldest month is January. The monthly maximum, mean and minimum temperatures for 1978 to 2016 are provided in Figure 6-1. The extreme minimum temperature recorded in Al Jouf was logged in January 1989 (i.e. -7^{o}C) and the extreme maximum temperature recorded was logged in August 2016 (i.e. 47.2^{o}C).

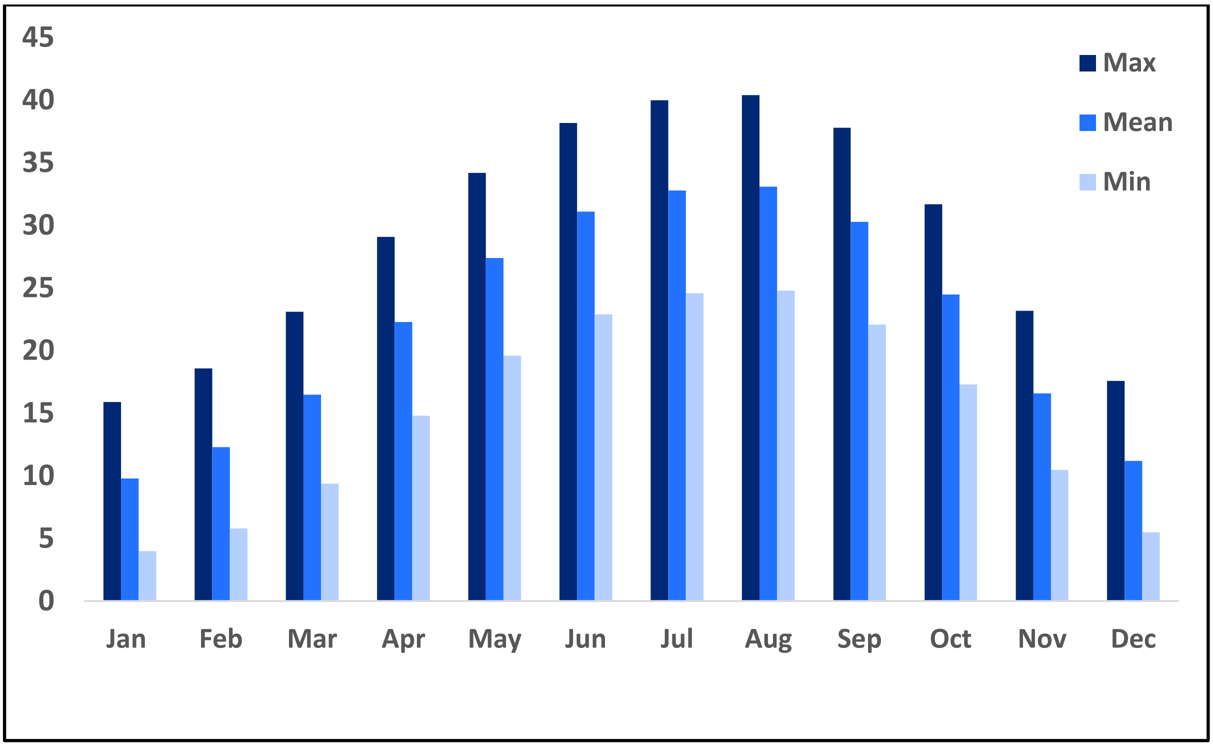


Figure 6-1: Monthly Temperature for Al Jouf from 1978 to 2016 (ºC)

6.3.1.3 Humidity

The monthly maximum, mean and minimum humidity data collected at Al Jouf airport meteorological station over the period 1978 to 2016 are shown in Figure 6-2.

The data shows a large seasonal variation in monthly mean humidity throughout the year. Mean humidity ranges from 16% in the summer (i.e. June and July) to 55% in the winter (i.e. December and January).

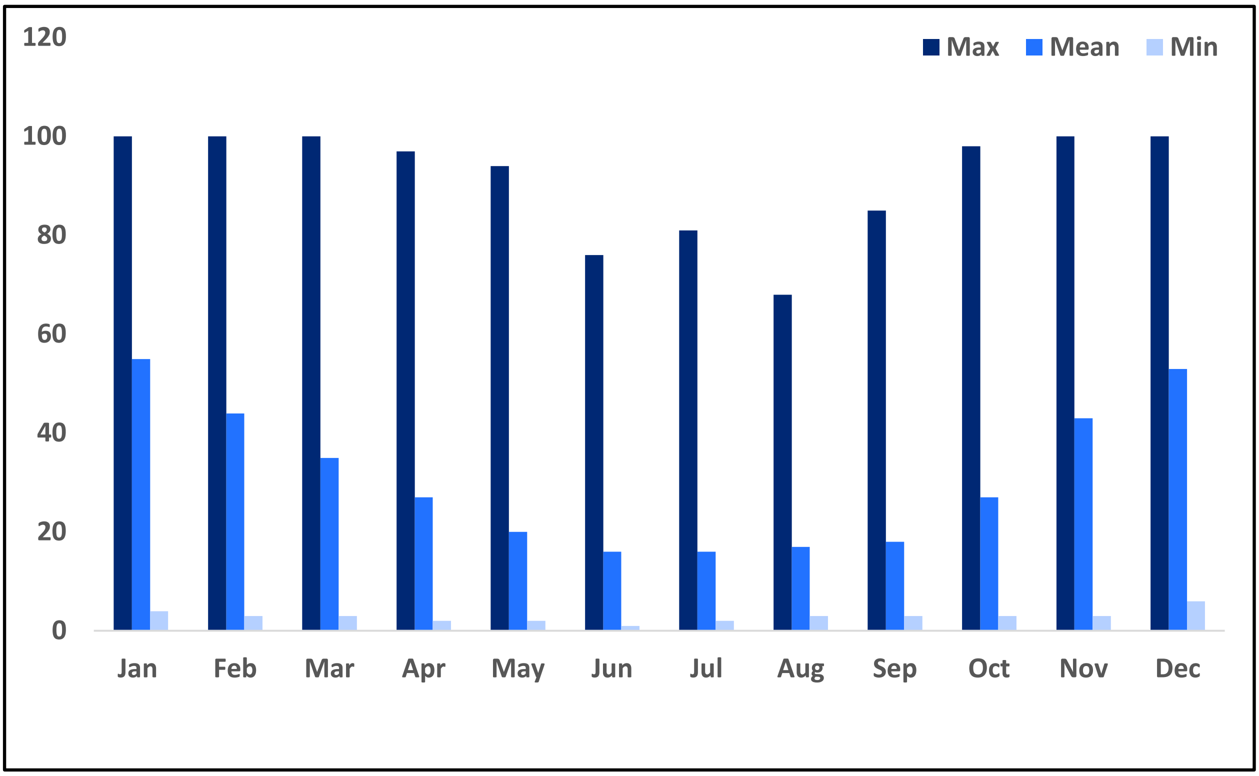


Figure 6-2: Monthly Humidity for Al Jouf from 1978 to 2016 (%)

6.3.1.4 Precipitation

Figure 6-3 shows that the monthly mean precipitation for Al Jouf over the monitoring period (i.e. 1978-2016) is 0-0.4mm in summer and 6.3–10.5mm in winter. There is almost no precipitation in the months from May to August. The highest total precipitation value of 10.5mm was recorded in January 2002.

There is significant variation between the monthly mean values of precipitation and the monthly extreme events. The most significant event occurred in November 2003 when 63.5mm of rain fell.

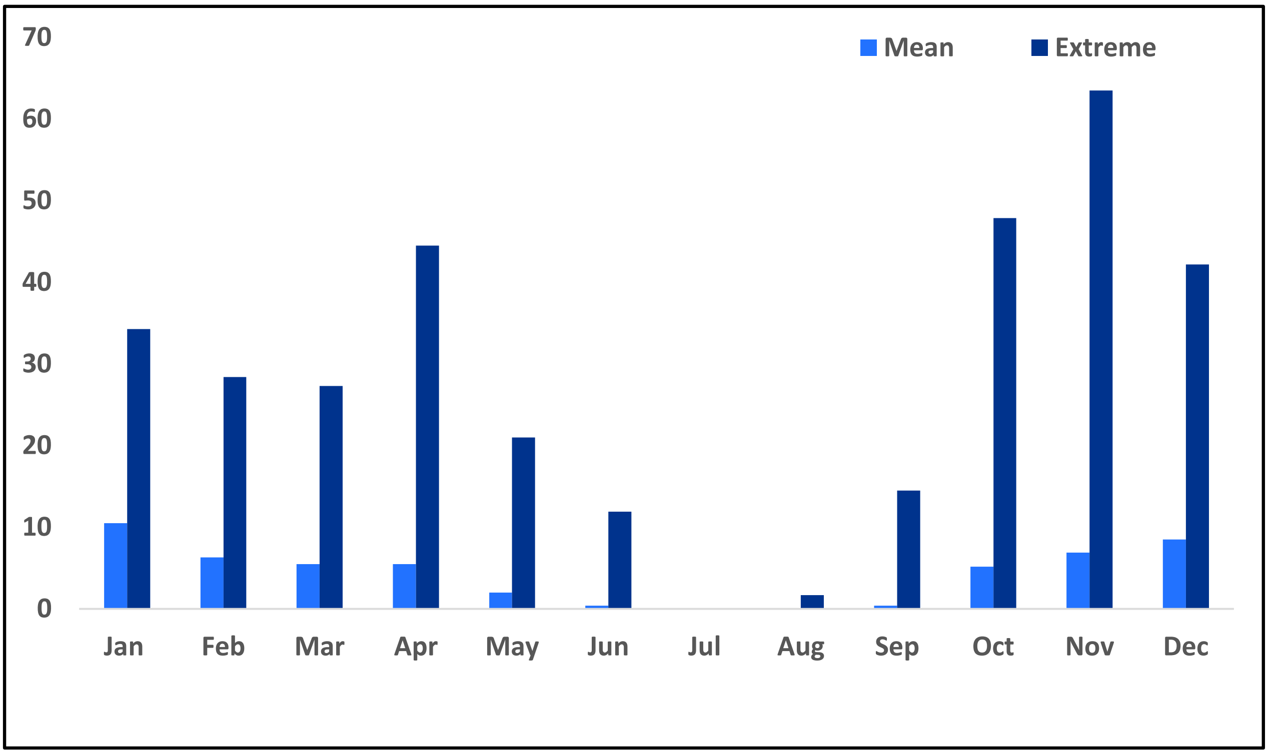


Figure 6-3: Monthly Mean & Extreme Precipitation for Al-Jouf from 1978 to 2016 (mm)

6.3.1.5 Wind

Saudi Arabia’s winds are highly complex and variable due to a combination of effects from large scale (synoptic) flows, high terrain, hot sandy deserts, and large, irregularly shaped water bodies. The three prevailing winds over the Arabian Gulf are the winter and summer Shamal (‘north’) winds, Kous (‘south-east’) winds, and sea breezes. The Shamal and Kous are larger scale winds with effects felt over the whole Arabian Gulf.

In summer, the high temperatures over the Arabian Peninsula lead to the development of Tropical Continental air which forms part of the Monsoon low circulation centered over north-west India. During this period the very dry and intense convection raises vast quantities of dust into the lower atmosphere and gives rise to poor visibility and generally hazy conditions (Vincent, 2008).

Throughout the year, the mean monthly wind speed ranges between 6 and 9 knots and shows minimal variation. The maximum monthly wind speeds are typically recorded during the spring transitional months (i.e. 60 knots).

The meteorological data from Al Jouf airport meteorological station over the period 1978 to 2016 shows that the prevailing wind direction is westerly.

6.3.1.6 Dust Storms

Dust storms play a major part in the weather of Saudi Arabia and these events influence air quality in the Arabian Gulf region. Airborne impacts have recently been exacerbated due to grazing pressure and subsequent reduction in vegetation cover increasing wind erosion. Soil moisture, an inhibiting factor to dust production, is very low in the Arabian Gulf region. Therefore, soils are highly erodible, particularly during periods of higher wind speeds.

Key airborne dust particle ('particulate matter') indicators are:

- For the protection of human health, Particulate Matter 10 (PM10); and PM2.5. PM10 is the mass concentration of airborne particulate matter comprising a collection of particles with aerodynamic diameters less than 10 microns. Similarly, PM2.5 is the indicator for the collection of particles less than 2.5 microns in size.
- For the protection of amenity, Total Suspended Particulates (TSP) comprising particles up to sizes of approximately 30-50 microns; and simple dust deposition comprising particles of all sizes.
- In relation to construction activities, research undertaken in the USA suggests that 85% to 90% by weight of the fugitive dust emissions of PM10 from construction sites are PM2.5-10 and 10% to 15% are in the PM2.5 fraction (IAQM, 2011).

Dust storms are predominantly made up of suspended silt and dust particulates and generally originate on the northern side of the Arabian Gulf from the clay soils of Iran and the silty-clayey soils of Kuwait and Iraq (especially the Tigris and Euphrates River basins) (Goudie and Middleton, 2001). During dust transport, the largest particles in the dust storm (with the most mass) fall out of suspension earlier than smaller sized aerosols. Visibility is reduced to a few meters in severe dust storms with very high particulate concentration. Aeolian or wind transport may be facilitated in three ways:

- Suspension – small particles (silt, dust) suspended in air;
- Saltation – larger particles (sand particles) which are lifted and continuously dropped out of the air column, "hopping" along the land surface; and
- Surface creep – largest particles (pebble size) which are pushed along the ground, they may be transported by other saltation grains.

Dust source activity in the Arabian Gulf region is greatest during pre-monsoonal (spring) and monsoonal (summer) periods, typically when strong Shamal winds tend to blow. This corresponds with the long-term meteorological data-set provided by GAME for 1978 to 2016. The recorded days of blowing dust and dust storms occur with greatest frequency between February and May.

6.3.1.7 Thunder Storm

Most rainfall extremes are associated with intense thunderstorms. The data from Al Jouf airport meteorological station over the period 1978 to 2016 shows that thunderstorms occur most frequently in autumn and winter (i.e. October to March).

6.3.2 Local Meteorological Conditions

6.3.2.1 Monitoring Stations

The Saudi Aramco Power Systems Renewables Development (PSDP) group installed meteorological masts within the developable area of the Park to measure the wind resource. Four meteorological masts (i.e. AJ1, AJ2, AJ3 and AJ4) were installed between May and June 2015. A summary of the meteorological masts is provided in Table 6-5, and the location of the masts is illustrated on Figure 6-4.

Table 6-5: Meteorological Mast Summary Data

Name	Installation date	Latitude	Longitude	Elevation (m)	Duration of data set
Mast AJ1	30 May 2015	30.00	39.79	785	16 Months
Mast AJ2	27 May 2015	29.96	39.89	815	16 Months
Mast AJ3	28 May 2015	29.99	39.85	805	16 Months
Mast AJ4	01 Jun 2015	30.03	39.83	800	16 Months

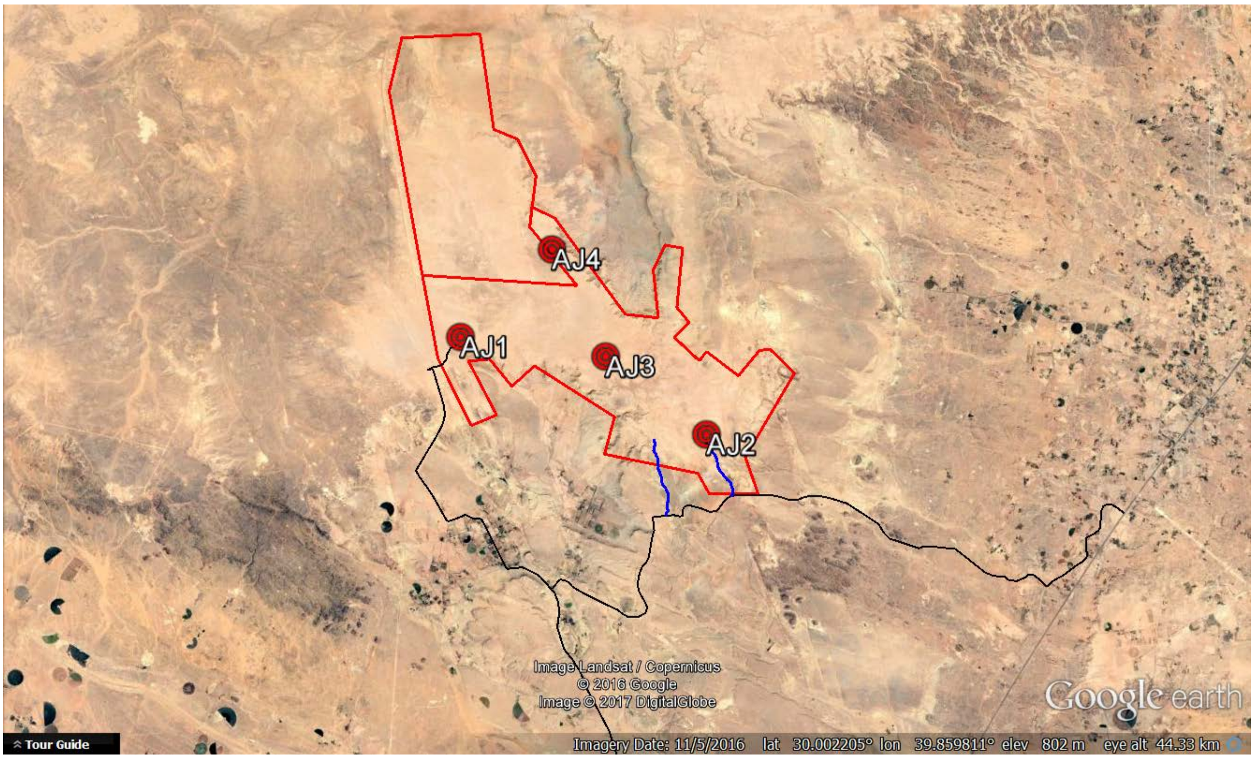


Figure 6-4: Meteorological Monitoring Station

6.3.2.2 Wind Resource

Anemometers were installed on each meteorological mast at heights of 92 m to measure wind speed. The annual average wind speed for the meteorological masts used in the energy yield assessment are presented in Table 6-6; and the maximum 10-minute wind speed at 92 m and maximum 1 second gust speed at 92 m are listed in Table 6-7.

Table 6-6: Average Annual Wind Speed

Name	Anemometer height	Site period annual average wind speed (m/s)
Mast AJ1	92	7.0
Mast AJ2	92	6.9
Mast AJ3	92	6.9
Mast AJ4	92	6.7

Table 6-7: Measured Wind Speed Summary

Name	Maximum 10 minute wind speed at 92m (m/s)	Maximum 1 second gust at 92m (m/s)
Mast AJ1	24.0	36.8
Mast AJ2	22.4	30.2
Mast AJ3	24.3	30.1
Mast AJ4	24.4	30.5

The diurnal wind speed profiles for each mast have been calculated and are reported in the Dumat Al Jandal Wind Farm Energy Yield Assessment report (DNV GL, 2017). The annual wind speed profile for mast AJ1 is illustrated in Figure 6-5 and this pattern is indicative of the remaining masts. Wind speeds are typically higher during the early hours of the morning and late afternoon to evening, and show a decline during the middle part of the day.

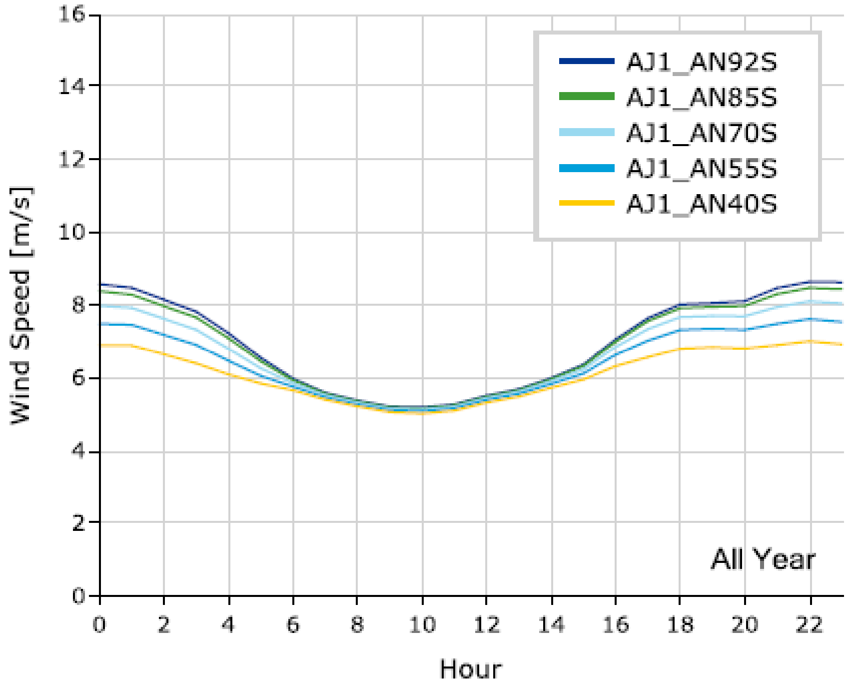


Figure 6-5: Diurnal wind speed profiles at Masts AJ1

6.3.2.3 Temperature

Temperature was measured at heights above ground level of 89 m and 4 m. The mode temperature is the temperature occurring with the greatest frequency throughout the year. This was typically represented by a frequency of approximately 5 %. These measurements, along with the annual minimum and maximum temperatures are shown in Table 6-8.

Table 6-8: Annual Temperature Data

Mast	Annual Minimum Temperature (ºC)	Annual Mode Temperature (ºC)	Annual Max Temperature (ºC)
1	1	32.5	43
2	1	32.5	43
3	1	30	43
4	0.5	29.5	43

6.3.3 Air Quality Baseline Environmental Conditions

6.3.3.1 Existing Sources

The primary source of point source emissions adjacent to the development site is the gypsum quarry located 3 km to the east of the development site boundary. Emissions at this quarry include vehicular emissions (e.g. forklifts, excavators and other operational plant), and dust and fugitive emissions from on-site batching and quarrying operations. Figure 6-6 shows emissions from the quarry, and Figure 6-7 shows the batching plant at the quarry. Fugitive dust emissions from this quarry have also been observed where un-protected spoil is stored (Figure 6-8).

Figure 6-6: Gypsum Quarry Emissions

Figure 6-7: Gypsum Quarry Operational Plant

Figure 6-8: Unprotected Spoil Stored at Gypsum Quarry

6.3.3.2 Mobile Emissions Sources

Mobile emission sources identified within the developable area of the Park are limited to intermittent 4x4 vehicles. These are typically driven by nomadic herders and those camping in the desert. Petrol and diesel-engine motor vehicles emit a wide variety of pollutants, principally carbon monoxide (CO), oxides of nitrogen (NO_x), volatile organic compounds (VOCs) and particulate matter (PM_{10}), which have an increasing impact on urban air quality. In addition, pollutants from these sources may not only prove a problem in the immediate vicinity of these sources, but can be transported long distances.

6.3.3.3 Natural Sources

Due to high winds in the vicinity of the development site, wind-blown particulate matter is a significant source of air pollution. Saudi Aramco Engineering Standard 112, Meteorological and Seismic Design Data (SAES-112), contains information regarding the concentrations of dusts and particles.

"The mass of total suspended airborne particulate matter per unit volume of air. Usual airborne dust concentration is 1 mg/m³. During sandstorms, dust concentrations may reach 500 mg/m³. Particle sizes are as follows:

- *95 % of all particles are less than 20 micrometers.*
- *50 % of all particles are less than 1.5 micrometers.*

Elements present in dust include compounds of calcium, silicon, magnesium, aluminum, potassium, chlorides and sodium. When wetted (high humidity conditions) these compounds function as electrolytes and can result in severe corrosion.

Other pollutants present in the atmosphere under the most extreme conditions are:

- *H_2S 20 ppm (vol/vol).*
- *Hydrocarbon 150 ppm (vol/vol).*
- *SO_2 10 ppm (vol/vol).*
- *CO 100 ppm (vol/vol).*
- *NO_x 5 ppm (vol/vol).*
- *O_3 1 ppm (vol/vol)."*

The assessment requires characterization of the existing conditions with regard to PM_{10} concentrations to determine the sensitivity of the area. No local monitoring data is available; it is therefore believed that the annual mean PM_{10} concentration would be relatively low. However, during infrequent dust storms high concentrations of PM_{10} are experienced for short periods of time (see Appendix A).

A PM_{10} concentration of greater than 16 $\mu g/m^3$ has been assumed and used in this assessment to represent the baseline conditions. This is conservative and based on factoring the IAQM guidance (IAQM, 2016) concentrations to take account of the difference between the UK air quality standard (under which the IAQM guidance was developed) for PM_{10} of 40 $\mu g/m^3$ and the IFC ambient air quality guideline for PM_{10} of 20 $\mu g/m^3$.

6.4 Impact Assessment

6.4.1 Assumptions

The assessment of impact for construction related dust emissions has assumed that the IPP will implement best practice measures for dust control as part of an agreed Dust Management Plan. Based on the Institute of Air Quality Management Guidance on the Assessment of Dust from Demolition and Construction (IAQM, 2016), good practice dust management measures are listed in Table 6-9 to Table 6-14. The applicability of these measures to the development of the Park are specified as highly recommended, desirable and not required.

Table 6-9: Mitigation for all sites: communications

Mitigation measure	Highly recommended / Desirable / Not required
1. Develop and implement a stakeholder communications plan that includes community engagement before work commences on the Park.	Desirable
2. Display the name and contact details of person(s) accountable for air quality and dust issues on the Park boundary. This may be the environment manager/engineer or the site manager.	Highly recommended
3. Display the head or regional office contact information.	Highly recommended

Table 6-10: Mitigation for all sites: dust management

Mitigation measure	Highly recommended / Desirable / Not required
4. Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the Amana. The level of detail will depend on the risk, and should include as a minimum the highly recommended measures in this assessment. The desirable measures should be included as appropriate for the Park.	Desirable
Site management	
5. Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner and record the measures taken.	Desirable
6. Make the complaints log available to the Amana when asked.	Desirable
7. Record any exceptional incidents that cause dust and/or air emissions, either on-site or off-site, and the action taken to resolve the situation in the log book.	Desirable
8. Hold regular liaison meetings with other high-risk construction sites within 500m of the Park boundary, so plans are coordinated and dust and particulate matter emissions are minimized. It is important to understand the interactions of the off-site transport/deliveries which might be using the same strategic road network routes.	Not required
Monitoring	
9. Undertake daily on-site and off-site inspection, where receptors (including roads) are nearby, to monitor dust and record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of the Park boundary, with cleaning to be provided if necessary.	Not required
10. Carry out regular site inspections to monitor compliance with the DMP, record inspection results and make an inspection log available to the Amana when asked.	Desirable
11. Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	Desirable
12. Agree dust deposition, dust flux or real-time PM_{10} continuous monitoring locations with the local authority. Where possible, commence baseline monitoring at least three months before work commences on site or, if at a large site, before work on a phase commences. Further guidance is provided by IAQM on monitoring during demolition, earthworks and construction.	Not required
Preparing and maintaining the site	
13. Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	Highly recommended
14. Erect solid screens or barriers around dusty activities, or the Park boundary, which are at least as high as any stockpiles on site.	Not required
15. Fully enclose site or specific operations where there is a high potential for dust production and the Park is active for an extensive period.	Highly recommended
16. Avoid site runoff of water or mud.	Not required
17. Keep Park Site fencing, barriers and scaffolding clean using wet methods.	Not required

Mitigation measure	Highly recommended / Desirable / Not required
18. Remove materials that have a potential to produce dust from the Park as soon as possible, unless being re-used on site. If they are being re-used on-site, cover as described below.	Not required
19. Cover, seed or fence stockpiles to prevent wind whipping.	Not required
Operating vehicle/machinery and sustainable travel	
21. All vehicles to switch off engines when stationary - no idling vehicles.	Highly recommended
22. Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.	Not required
23. Impose and signpost a maximum speed limit of 15mph on surfaced and 10mph on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate).	Desired
24. Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	Highly recommended
25. Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking and car sharing).	Not required
Operations	
26. Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.	Highly recommended
27. Ensure an adequate water supply on the Park for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.	Highly recommended
28. Use enclosed chutes and conveyors and covered skips.	Highly recommended
29. Minimize drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.	Highly recommended
30. Make sure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	Desirable
44. Avoid dry sweeping of large areas.	Highly recommended
45. Make sure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	Highly recommended
46. Inspect on-site haul routes for integrity and instigate any necessary repairs to the surface as soon as reasonably practicable.	Highly recommended
47. Record all inspections of haul routes and any subsequent action in a site log book.	Highly recommended
48. Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers, and regularly cleaned.	Highly recommended
Waste management	
31. Avoid bonfires and burning of waste materials.	Highly recommended

Table 6-11: Mitigation measures specific to demolition

Mitigation measure	Highly recommended / Desirable / Not required
32. Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	Desired
33. Use effective water suppression during demolition operations. Hand held spays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high-volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	Desired

Mitigation measure	Highly recommended / Desirable / Not required
34. Avoid explosive blasting, using appropriate manual or mechanical alternatives.	Not required
35. Bag and remove any biological debris or damp down such material before demolition.	Not required

Table 6-12: Mitigation measures specific to earthworks

Mitigation measure	Highly recommended / Desirable / Not required
36. Re-vegetate earthworks and exposed areas/soil stockpiles to stabilize surfaces as soon as practicable.	Not required
37. Use hessian fabric, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	Not required
38. Only remove the cover in small areas during work and not all at once.	Not required

Table 6-13: Mitigation measures specific to construction

Mitigation measure	Highly recommended / Desirable / Not required
39. Avoid scabbling (roughening of concrete surfaces) if possible.	Desired
40. Store sand and other aggregates in bunded areas and do not allow to dry out unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.	Not required
41. Deliver bulk cement and other fine powder materials in enclosed tankers and store in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	Desired
42. For smaller supplies of fine powder materials, make sure bags are sealed after use and stored appropriately to prevent dust generation.	Desired

Table 6-14: Mitigation measures specific to track-out

Mitigation measure	Highly recommended / Desirable / Not required
43. Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use.	Desired
49. Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	Not required
50. Provide an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.	Not required
51. Access gates to be located at least 10m from receptors where possible.	Not required

6.4.2 Assessment Methodologies

This section sets out the assessment of emissions which could potentially occur from the construction of the Park. The risks of impacts and associated mitigation measures identified for the construction are assumed to be applicable for the future phases of the Park as the site is fully developed. A description of the approach taken to complete the air quality assessment is presented in Appendix A of this Environmental Statement.

6.4.2.1 Construction dust

Activities carried out on construction sites can give rise to emissions of dust which could cause annoyance to human receptors or damage to vegetation due to the soiling of surfaces. Dust could also lead to increased short term and long term particulate matter concentrations (e.g. PM_{10} and $PM_{2.5}$, particulate matter with aerodynamic diameter less than 10 microns (µm) or 2.5 µm or less, respectively) at off-site locations that may affect human health, unless the appropriate mitigation measures are implemented. The impacts of dust emissions from construction therefore need to be addressed in order to identify the required mitigation measures.

This assessment has been carried out in accordance with the latest IAQM guidance (IAQM, 2016) on the assessment of dust from demolition and construction. This report sets out the full construction dust assessment, including description of the methodology, relevant input data, the assessment itself, recommended mitigation and monitoring measures and conclusions.

IAQM guidance aims to estimate the impacts of both PM_{10} and dust together, through a combined risk-based assessment procedure. IAQM guidance provides a methodological framework, but notes that professional judgement is required to assess impacts. This assessment does not consider the air quality impacts of dust from any contaminated land or buildings. Although $PM_{2.5}$ is not specifically included as a parameter within the assessment, the risk levels associated with PM_{10} and any subsequent mitigation measures would apply to $PM_{2.5}$.

6.4.2.2 Combustion equipment

Two 500 kW generators are proposed for the construction phase, to provide electrical power for both the workers accommodation and other construction related activities. Typically, only two generators will operate simultaneously. An additional standby generator would be present on site for back-up. If only two generators operate the aggregated size of the generators would fall outside the IFC guidelines for small combustion plant (between 3 MWth and 50 MWth). However, the generators to be used will comply with the emission standards set out in the GAME environmental standards for air emissions from stationary sources. The diesel fuel used for the generators will have a sulfur content less than 1.5%, in line with the requirements set out in Section 1 of the IFC General EHS guidelines 2007. The location of the generators is proposed to be greater than 500 m from the workers accommodation. Therefore, an assessment of emissions to air from the generators has been screened out and is not considered further in this assessment. It is noted that the generators have been included in the assessment of GHG emissions.

The operational phase of the Park does not have any significant diesel (or other fossil fuel) powered energy generating plant (such as boilers or generators) and only requires a low number of maintenance and staff vehicle movements. Therefore, there will be no significant emissions to air and an air quality assessment of emissions to air during the operational phase of the Park has been screened out and is not considered further in this assessment.

6.4.2.3 Greenhouse gases

The GHG emissions have been evaluated based on CO_2 equivalent and estimated based on fuel consumption. The method used to calculate the project's operational carbon is based on the GHG Protocol, assessed in accordance with Saudi Aramco Engineering Procedure 13 (SAEP-13) and guidance from the UK Government's Department of Energy and Climate Change (DECC, 2009). These methods are in accordance with the requirements of both IFC Performance Standard 3 and Equator Principle 3 and consider both Scope 1 and Scope 2 emissions. The process involves:

- identifying the activities/processes which release GHG;
- categorization of the activities by scope; and,
- quantification of the emissions.

This assessment includes CO_2 emissions associated with the following elements of the project:

- emissions from fuel used during transport of construction materials, cables and turbine components to the Park;
- emissions from fuel used by the plant and equipment required for the construction, operation and decommissioning phase; and,
- emissions during production of the raw materials used for the construction of the Park, such as steel, copper and concrete.

A description of the approach taken to complete the air quality assessment is presented in Appendix A of this Environmental Statement.

6.4.3 Construction Phase Impact Assessment Approach

6.4.3.1 Step 1: Identify the need for a detailed assessment

Sensitive human receptor

There are human receptors within 350 m of the site boundary. Therefore, further assessment is required. One receptor has been identified within the site area; a seasonal herder settlement. Seasonal herder settlements are not permanent receptors but, for the purposes of this assessment they have been classed as permanent receptors. However, though during construction seasonal herders are unlikely to set up camps adjacent to areas of phased construction, there is a risk the herders may camp near the fenced construction work area with construction works close on the other side. Therefore, as a conservative approach we have considered these seasonal receptors to be located between 20 m – 50 m from areas of construction. In reality these receptors would locate themselves further away from construction activities.

Several plots of semi-formal ‘garden’ planting were recorded within the developable area. The purpose of this planting is unclear but each plot consists of a post and wire fence surrounding between one and five trees, grown in empty oil drums which have been filled with soil. There is evidence of recent maintenance in these locations in the form of hoses and water buckets.

A count of the relevant human receptors within the specified assessment bands was carried out as recommended in IAQM guidance, the results of which are set out in Table 6-15. The receptors have been identified as being of High sensitivity in line with Step 2B.

In line with the IFC guidance construction workers are also required to be considered as sensitive human receptors. However, although there are expected to be over 600 workers, not all of the workers will be exposed to the potential dust generating construction activities. Therefore, it has been assumed that there will be between 1-10 workers within 20 m of construction activities, and greater than 10 workers for each of the other distance bands.

There are no human receptors within 50 m of the road network that lies within 500 m of the site entrance and therefore trackout[4] has not been considered further in the assessment. Similarly there are no receptors within 350 m of the proposed SEC service road. Therefore, an assessment of construction related activities on the SEC service road are screened out and are not considered further in this assessment.

Table 6-15: Dust soiling and human receptor count

Receptor count				
Demolition, Earthworks & Construction		**Receptor sensitivity**		
		High	**Medium**	**Low**
Distance from the Park boundary	<20m	0	1-10	0
	20m–50m	1	>10	0
	50m–100m	0	>10	0
	100m–350m	2	>10	0
Distance from SEC service road	No receptors within 350m			
Trackout		**High**	**Medium**	**Low**

[4] Trackout refers to the transport of dust and dirt from the site area onto the public road network, where it may be deposited and re-suspended by other vehicles using the road network. Only receptors within 50 m of the route(s) used by vehicles on the public highway up to 500 m from the Park entrance are considered to be at risk.

Receptor count	
Distance from roads up to 500m from the proposed site exit	No receptors within 50m of access roads.

Ecological receptors

Dust can have direct physical effects including reduced photosynthesis, respiration and transpiration through coating and smothering. Chapter 11 demonstrates that there are no ecology sites within the relevant distances from the site boundary.

6.4.3.2 Step 2: Assess the risk of dust impacts

6.4.3.2.1 Step 2A: Define the potential dust emission magnitude

The construction works will be split into several phases, which will involve different periods of earthworks, construction and trackout, and activity levels which will not peak simultaneously. Conservatively, this assessment is based on construction of the entire Park. The risks and mitigation measures identified are applicable to future construction phases of the Park.

Construction activities are split into two periods as follows.

- Pre-construction, which will last approximately four months, during which the roads for the site will be laid down and the individual crane pads at each turbine location will be developed.
- Construction, which is assumed to last 16 months, during which the concrete turbine foundation pads will be constructed, the turbines erected and the cabling infrastructure will be emplaced.

The dust emission magnitudes of each activity have been specified using the definitions of dust emission magnitudes in appendix A. These are summarized in Table 6-16.

Demolition: The development site encompasses undeveloped land, no demolition will be required, therefore, demolition is not considered further in this assessment.

Earthworks: For earthworks activities associated with Pre-construction at The Park, the total area of earthworks is estimated to be approximately 616,750 m^2. For earthworks activities associated with the Construction period at The Park, the total area of earthworks is estimated to be approximately 198,120 m^2. On this basis, the proposed earthworks have been classified as a dust emission class of ‘Large’.

Construction: The total construction volume associated with the construction of the roads and crane hard standing areas has an estimated volume of 92,393 m^3. The total construction volume associated with the construction of the turbine foundations has an estimated volume of 60,720 m^3. On this basis, the assessment for construction is based on a dust emission class of ‘Medium’ (equivalent to ‘Moderate’ in the assessment methodology outlined in chapter 5).

Trackout: During construction, the maximum number of daily outward movements of HGVs is anticipated to be less than 50. However, there are no human receptors within 50 m of the road network that extends up to 500 m from the site entrance, therefore trackout has not been considered further in the assessment.

Table 6-16 presents as a summary of the dust emission magnitude for each activity based on the criteria set out in Appendix A.

Table 6-16: Dust emission magnitude

Activity	Dust emission magnitude
Demolition	N/A
Earthworks	Large
Construction	Medium/Moderate
Trackout	N/A

6.4.3.2.2 Step 2B Define the sensitivity of the area

The area surrounding the development site is inhabited by permanent, semi-permanent and temporary farm developments. If the proposed activities produce excessive dust emissions, significant impacts may be experienced at sensitive receptors unless suitable mitigation measures are employed. These mitigation measures will also protect the construction workers. It is noted that the location of the site is in desert terrain and so typical levels of dust regularly experienced would be greater than those generated during the construction of the Park. Therefore, the general sensitivity of the area to additional dust would be low.

Effects on human health are considered within this assessment to assign the suitable mitigation measures but the impacts are described separately in Chapter 17 Health and Safety Aspects.

Table 6-17 displays the sensitivities of the surrounding area to demolition, earthworks, construction and trackout based on the criteria set out in Appendix A.

Table 6-17: Sensitivity of the area for human receptors

Potential Impact	Sensitivity of the surrounding area			
	Demolition	Earthworks	Construction	Trackout
Dust soiling	N/A	Low	Low	N/A
Human health		Low	Low	

Table 6-17 shows that, based on the number and proximity of sensitive receptors to the development site and background PM_{10} concentration, the sensitivity of the area for dust soiling and human health impacts is categorized as Low for earthworks and construction activities.

The sensitivity of human receptors to demolition and trackout activities is categorized as ‘N/A’ as there are no demolition activities anticipated and no receptors that will be affected by trackout.

Step 2C Define the risk of impacts

Using the dust emission magnitudes for the various activities in Table 6-16 and the sensitivity of the area provided in Table 6-17, the definition of the risks for each activity are provided in Table 6-18 for dust soiling impacts.

Table 6-18: Summary of the dust risks for human receptors

Potential impact	Risk			
	Demolition	Earthworks	Construction	Trackout
Dust soiling	N/A	Low	Low	N/A
Human health		Low	Low	

The results in Table 6-18 indicate that for potential dust soiling impacts and for potential human health impacts, there is predicted to be a Low risk for earthworks and construction activities.

6.4.3.3 Summary

The results in Table 6-18 indicate that there would be Low or no risks to sensitive human receptors for dust soiling or human health effects during earthwork and construction activities. It is noted that the location of the site is in desert terrain and so typical levels of dust regularly experienced would be greater than those generated during the construction of the Park. However, in order to follow best practice, it would be necessary to adopt mitigation measures to reduce the potential for effects to occur at nearby sensitive receptors.

6.4.4 Operation Phase Impact Assessment Approach

The operational phase of the Park does not have any significant diesel (or other fossil fuel) powered energy generating plant (such as boilers or generators) and only requires a low number of maintenance and staff vehicle movements. Therefore, there will be no significant emissions to air and no further assessment is required.

6.4.5 Decommissioning Phase Impact Assessment Approach

For the decommissioning phase of the Park, it is assumed that the risk of dust emissions or dust soiling associated with the construction phase (as provided in Table 6-18) are also likely to be expected for the decommissioning phase, with the construction phase risks being assigned to the demolition activity.

6.4.6 Greenhouse Gas Emissions

CO_2 emissions are assessed for the following elements of the project:

- emissions from fuel used during transport of construction materials, cables and turbine components to the Park;
- emissions from fuel used by the plant and equipment required for the construction, operation and decommissioning phase; and
- emissions during production of the raw materials used for the construction of the Park, such as steel, copper and concrete.

6.4.6.1 Transport

Table 6-19 shows the calculation of CO_2 emissions related to the following elements of the project.

- road transport of the construction materials from various suppliers to the Park (assumed to be from an average distance of 35 km),
- shipping of the turbine tower components from Shanghai to Jubail (11,000km), then onward transport by road to the Park (1,181 km, including 10 km for road freight in China).
- shipping of the turbine nacelle components and turbine blades from one of several locations in Europe to the port at Split (assumed distance of 1,000 km), then by Sea from Split to Aqaba (3,000 km), and finally by road from Aqaba to the Park (669 km).

Table 6-19: CO_2 emissions from transport

Transport Route	Mode	HDV numbers / tons of turbine components	Distance travelled (one-way) (km)	Cumulative distance (km)	CO_2 emissions factor	CO_2 emissions (tons)
Pre-construction (gravel/ashphalt/fencing)	Road	4,830	35	338,120		384
Construction - ReadyMix/water	Road	3,302	35	231,150	1.134 kg CO_2e/km	262
Construction - rebar/cabling	Road	434	35	29,345		34
Turbine tower delivery	Road	396	1,181	935,352		1,061

Transport Route	Mode	HDV numbers / tons of turbine components	Distance travelled (one-way) (km)	Cumulative distance (km)	CO_2 emissions factor	CO_2 emissions (tons)
Turbine nacelle delivery	Road	528	1,669	1,762,464		1,994
Turbine tower	Ship	29,436 tonnes	11,000	11,000	0.016 kg CO_2e/tonne.km	1,417
Turbine nacelle	Ship	62,964 tonnes	3,000	3,000		3,038
Total Transport CO_2 emissions						**8,187**

6.4.6.2 Plant and equipment

Table 6-20 shows the calculation of CO_2 emissions from the plant and equipment to be used on site for the construction, operation and decommissioning of the Park using the diesel emission factor of 0.268 kg CO_2e/kWh.

Table 6-20: CO_2 emissions from plant and equipment

Stage	Description	Total daily power (kWh-day)	Duration (months)	Total power (kWh)	CO_2 emissions (tons)
Pre-construction	Installation of access roads	36,344	4	4,421,829	1,183
	Site Grading	27,432	4	3,337,560	893
	Install fencing/lighting	3,402	4	413,910	111
	Install Construction Compound	5,148	4	626,340	168
Construction	Install Foundations for turbines	125,190	16	60,925,800	16,301
	Installing Wind Turbines	7,170	16	3,489,400	934
	Installing Cabling	17,370	16	8,453,400	2,262
	Power Supply at Construction Site	24,000	16	11,680,000	3,125
Total Construction					**24,976**
Operation (per year)		14,780	12	5,394,700	1,443
Decommissioning		188,929	16	91,945,447	24,601
Total Plant and Equipment CO_2 emissions					**51,020**

6.4.6.3 Construction Materials

Table 6-21 shows the calculation of CO_2 emissions from the production of the raw materials to be used on site for the construction of the Park.

Table 6-21: CO_2 emissions from production of raw materials

Material	Quantity (tons)	CO_2 emissions factor (t CO_2e/ t material	CO_2 emissions (tonnes)
Asphalt	56	0.086	5
Turbine foundations Ready Mix	145728	0.083	12,157
Copper cabling	589	2.71	1,758
Steel (rebar)	6072	1.4	8,501
Steel (turbine construction)	92,400	1.66	173,536

Total Materials CO_2 emissions	**175,643**

6.4.6.4 Total CO_2 Emissions

The total CO_2 emissions for the park are summarized in Table 6-22. In addition, the CO_2 emissions for the different elements have been annualized to allow for comparison to the Equator Principals limit of 100,000 tons of CO_2 emissions per year (it is noted that this limit is based on the operation of the project and does not specifically apply to the construction phase).

Table 6-22: Total CO_2 emissions from the Park

GHG Emission Source	CO_2 emissions (tons)	Annualized CO_2 emissions (tons)
Transport	8,772	5,263
Plant and Equipment - Construction	24,976	14,986
Construction Materials	195,955	117,573
Construction Total	**229,703**	**137,822**
Plant and Equipment – Operation (per year)	1,443	1,443
Plant and Equipment – Decommissioning	24,601	18,451

Based on the requirement of the equator principals, projects emitting more than 100,000 metric tons of CO_2 annually during operation are required to undertake an alternatives analysis. Table 6-22 shows that the annualized CO_2 emission for the Park (based on a construction duration of 20 months) is 137,822 tons which is greater than the 100,000 metric tons reporting limit. However, as mentioned previously, the limit of 100,000 tons of CO_2 is based on the operation of a project and is therefore not directly applicable for the construction phase.

When averaged over the lifetime of the Park, the total annual CO_2 emissions for the operational phase and decommissioning are below the 100,000 metric tons reporting limit.

During the next phase of the development, there will be a requirement to refine materials and equipment utilized in the construction of the Park in order to integrate the principles of cleaner production as specified in IFC Performance Standard 3 which require the investigation of financially feasible options for all resources.

The objective of this requirement is to promote the conservation of resources and the minimization of impacts associated with construction of infrastructure. During the detailed design phase of the Park, continuous improvement in design should be pursued in order to ensure that energy and resource efficiencies are identified and integrated into the design of the Park wherever possible.

In addition, it is expected that the Park will generate approximately 1,100 GWh per annum of energy, displacing 2,700 Thousand Barrels of Oil Equivalent (MBOE) of hydrocarbons and 1 million tons of CO_2 per annum. Therefore, the GHG emissions for the construction phase are considered not to be significant, and the overall impact of the development of the Park will represent an overall benefit (i.e. reduction) in GHG emissions; plus contribute to the Kingdom of Saudi Arabia's INDC target to annually abate up to 130 $MtCO_2e$ by 2030.

The annual CO_2 saving of 1 Mt should be able to be converted into Certified Emission Reductions (CER), once the appropriate procedures of the Clean Development Mechanism (CDM) Executive Board for emission reductions achieved by CDM projects and verified by a DOE (Designated Operational Entity) under the rules of the Kyoto Protocol are followed. Due to oversupply in carbon credit markets, the current CER price is ~ €0.2 – €0.3 / ton CO_2.

6.4.7 Impact Assessment Summary

Table 6-23 summarizes the impact significance of the project based on the criteria set out in Chapter 5.

Table 6-23: Summary of Impact Significance

ID	Receptor	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
AQ01 Construction Dust	Human receptors within 350m of construction activities	Low	Potential dust inhalation/ nuisance resulting from construction activities	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Frequent Duration: Short Extent: Local Permanence: Reversible	Low	Low
AQ02 GHG Emissions: Construction	N/A	Moderate	Increase GHG emissions from the construction of the Park	Effect: Negative Action: Direct Likelihood: Certain Frequency: Frequent Duration: Short Extent: International Permanence: Irreversible	Low	Low
AQ03 GHG Emissions: Operation	N/A	Moderate	Overall reduction in GHG emissions due to the operation of the Park	Effect: Positive Action: Indirect Likelihood: Certain Frequency: Frequent Duration: Long Extent: International Permanence: Irreversible	Moderate	Moderate benefit

6.4.8 Mitigation

6.4.8.1 Construction Phase

The effects during the construction phase are temporary and the impacts will be short term and will only arise during specific construction activities. Following the application of the good practice dust control and mitigation measures it is considered that impacts at all receptors would be 'not significant' in accordance with the IAQM guidance (see section 6.4.1).

6.4.8.2 Operation Phase

Although the overall impact of the Park is considered to be a benefit, to reduce the emissions of GHG during the operational phase, the use of electric vehicles is recommended.

6.4.8.3 Decommissioning Phase

No additional mitigation, above the mitigation measures which are likely to be similar to those set out as part of the construction phase, are envisaged in relation to emissions of dust during decommissioning.

6.4.8.4 Impact Assessment Summary

Table 6-24 summarizes the impact significance of the Park based on the criteria set out in Chapter 5.

Table 6-24: Summary of Impact and Mitigation

ID	Potential Significance	Mitigation	Residual Significance
AQ1 Construction Dust	Low	None required beyond the good practice mitigation measures	Low
AQ2 GHG Emissions: Construction	Low	None required	Low
AQ3 GHG Emissions: Operation	Moderate benefit	Recommend the use of electric vehicles during the operation of the Park.	Moderate benefit

6.4.9 Conclusion

This chapter has set out a summary of the existing ambient air quality in the vicinity of the Dumat Al Jandal Wind Energy Park and the prediction of potential air quality impacts resulting from the construction, operation and decommissioning phases of the Park.

For construction, the results indicate that there would be Low or no risks to dust soiling at sensitive human receptors from construction of the Park.

The assessment of GHG emissions from the Park show that although CO_2 emissions are likely, particularly during the construction stage, the overall impact of the scheme is considered to be a ‘net benefit’ based on the displacement of emissions of CO_2 from the use of fuel oil as an alternative for power generation, and that it will contribute to the Kingdom of Saudi Arabia’s INDC target to annually abate up to 130 $MtCO_2e$ by 2030.

Therefore, it is concluded that the Dumat Al Jandal Wind Energy Park is acceptable from an air quality and greenhouse gas emissions basis.

6.4.10 References

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7. Soils and Geology

7.1 Introduction

This chapter presents the findings of the soils and geology baseline review and the impacts likely to arise as a result of the development of the Park. The assessment addresses regional and local geological and soil conditions, characterizes the soil and geological quality, and assesses potential impacts on receptors.

Baseline conditions and related impact assessment for surface and ground water are provided in Chapter 8 – *Hydrology & Hydrogeology*. Similarly, any impacts on the terrestrial environment relating to dust are covered in Chapter 6 - *Air Quality & Meteorology*.

7.2 International and National Standards and Guidance

7.2.1 IFC General EHS Guidelines

Soil erosion may occur due to disturbance of ground during construction and decommissioning of a development. This is considered in Section 4 of the IFC EHS Guidelines, which states that;

"Soil erosion may be caused by exposure of soil surfaces to rain and wind during site clearing, earth moving, and excavation activities. The mobilization and transport of soil particles may, in turn, result in sedimentation of surface drainage networks, which may result in impacts to the quality of natural water systems and ultimately the biological systems that use these waters."

The guidelines make recommendations on the reduction and prevention of erosion, management of runoff, design of roads, minimization of disturbance to water bodies and improvement of structural stability.

- *Sediment mobilization and transport*
- *Reducing or preventing erosion by:*
- *Scheduling to avoid heavy rainfall periods (i.e., during the dry season) to the extent practical*
- *Contouring and minimizing length and steepness of slopes*
- *Mulching to stabilize exposed areas*
- *Re-vegetating areas promptly*
- *Designing channels and ditches for post-construction flows*
- *Lining steep channel and slopes (e.g. use jute matting)*
- *Reducing or preventing off-site sediment transport through use of settlement ponds, silt fences, and water treatment, and modifying or suspending activities during extreme rainfall and high winds to the extent practical.*
- *Clean runoff management*
- *Segregating or diverting clean water runoff to prevent it mixing with water containing a high solids content, to minimize the volume of water to be treated prior to release*
- *Road design*
- *Limiting access road gradients to reduce runoff-induced erosion*
- *Providing adequate road drainage based on road width, surface material, compaction, and maintenance*
- *Disturbance to water bodies*
- *Depending on the potential for adverse impacts, installing free-spanning structures (e.g., single span bridges) for road watercourse crossings*

- *Restricting the duration and timing of in-stream activities to lower low periods, and avoiding periods critical to biological cycles of valued flora and fauna (e.g., migration, spawning, etc.)*
- *For in-stream works, using isolation techniques such as berming or diversion during construction to limit the exposure of disturbed sediments to moving water*
- *Consider using trenchless technology for pipeline crossings (e.g., suspended crossings) or installation by directional drilling*

▪ *Structural (slope) stability*

- *Providing effective short term measures for slope stabilization, sediment control and subsidence control until long term measures for the operational phase can be implemented*
- *Providing adequate drainage systems to minimize and control infiltration*

Section 1.8 of the IFC EHS Guidelines provides a summary of management approaches for land contamination due to anthropogenic releases of hazardous materials, wastes, or oil, including naturally occurring substances. Releases of these materials may be the result of historic or current site activities, including, but not limited to, accidents during their handling and storage, or due to their poor management or disposal (IFC, 2007).

Section 1.8 states that contaminated lands may involve surficial soils or subsurface soils that, through leaching and transport, may affect groundwater, surface water, and adjacent sites. Where subsurface contaminant sources include volatile substances, soil vapor may also become a transport and exposure medium, and create potential for contaminant infiltration of indoor air spaces of buildings (IFC, 2007).

Contaminated lands should be managed to avoid the risk to human health and ecological receptors. The preferred strategy for land decontamination is to reduce the level of contamination at the site while preventing the human exposure to contamination (IFC, 2007).

An approach to managing the risk of contaminated land is set out in the IFC General EHS Guidelines. To determine whether risk management actions are warranted, the following assessment approach should be applied to establish whether the three risk factors of ‘Contaminants’, ‘Receptors’, and ‘Exposure Pathways’ co-exist, or are likely to co-exist, at the project site under current or possible future land use:

- Contaminant(s): Presence of hazardous materials, waste, or oil in any environmental media at potentially hazardous concentrations;
- Receptor(s): Actual or likely contact of humans, wildlife, plants, and other living organisms with the contaminants of concern; and,
- Exposure pathway(s): A combination of the route of migration of the contaminant from its point of release (e.g., leaching into potable groundwater) and exposure routes (e.g., ingestion, transdermal absorption), which would allow receptor(s) to come into actual contact with contaminants (IFC, 2007).

7.2.2 IFC Performance Standard 3

Performance Standard 3 recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. Resource efficiency is the central tenet of this standard, and implementing technical and financially feasible and cost effective measures for improving efficiency in consumption of energy and water as well as other resources and material inputs (IFC, 2012).

The objectives for this Performance Standard are as follows:

- To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities;
- To promote more sustainable use of resources, including energy and water; and,
- To reduce project-related Greenhouse Gas (GHG) emissions.

The management of soil as a resource is referenced in Paragraph 6 of Performance Standard 3 *Resource Efficiency and Pollution Prevention,* Paragraph 8 of Performance Standard 4 *Community Health, Safety and Security* (i.e. ecosystem services) and Paragraph 14 of Performance Standard 6 *Biodiversity Conservation and sustainable management of Living Natural* Resources.

7.2.3 IFC Performance Standard 5

Performance Standard 5 recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood) as a result of project-related land acquisition and/or restrictions on land use. Resettlement is considered involuntary when affected persons or communities do not have the right to refuse land acquisition or restrictions on land use that result in physical or economic displacement. This occurs in cases of (i) lawful expropriation or temporary or permanent restrictions on land use and (ii) negotiated settlements in which the buyer can resort to expropriation or impose legal restrictions on land use if negotiations with the seller fail. The objectives of the performance standard are as follows:

- To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs.
- To avoid forced eviction.
- To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.
- To improve, or restore, the livelihoods and standards of living of displaced persons.
- To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.

Soil is a natural resource, the fertility of which could form the basis for livelihood at the development site. It is important therefore, to assess the impacts that loss of this resource could result in. Paragraph 28 of this Performance Standard states:

"In addition to compensation for lost assets, if any, as required under paragraph 27, economically displaced persons whose livelihoods or income levels are adversely affected will also be provided opportunities to improve, or at least restore, their means of income-earning capacity, production levels, and standards of living:

- *For persons whose livelihoods are land-based, replacement land that has a combination of productive potential, locational advantages, and other factors at least equivalent to that being lost should be offered as a matter of priority.*
- *For persons whose livelihoods are natural resource-based and where project-related restrictions on access envisaged in paragraph 5 apply, implementation of measures will be made to either allow continued access to affected resources or provide access to alternative resources with equivalent livelihood-earning potential and accessibility. Where appropriate, benefits and compensation associated with natural resource usage may be collective in nature rather than directly oriented towards individuals or households.*
- *If circumstances prevent the client from providing land or similar resources as described above, alternative income earning opportunities may be provided, such as credit facilities, training, cash, or employment opportunities. Cash compensation alone, however, is frequently insufficient to restore livelihoods."*

7.2.4 IFC Performance Standard 6

Performance Standard 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The requirements set out in this Performance Standard have been guided by the Convention on Biological Diversity, which defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems."

The objectives of this Performance Standard are as follows:

- To protect and conserve biodiversity.
- To maintain the benefits from ecosystem services.
- To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

With regard to local soils, paragraph 14 of this Performance Standard states that:

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

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

7.2.5 National Legislation

The GAME has not developed or published soil quality guideline values for the Kingdom of Saudi Arabia. U.S. Environmental Protection Agency (EPA) values are typically applied in the absence of national values.

7.3 Baseline Environmental Conditions

7.3.1 Baseline Review

7.3.1.1 Regional Geology

The geology of Saudi Arabia extends in age from the Precambrian era to the present day and forms part of a larger unit that includes the Arabian Peninsula, and is known as the Arabian Plate (www.sgs.org.sa). Based on the Saudi Geological Society classification system, Saudi Arabia can be divided into four distinct geological divisions as shown in Figure 7-1. These divisions are:

- Arabian Shield comprising metamorphosed volcano sedimentary successions intruded by granite and gabbro;
- Arabian Platform (cover rocks) of clastic, calcareous and evaporitic successions dipping gently eastward away from the shield;
- Tertiary and Quaternary harrats (extensive basalt plateaus) mainly overlying the shield; and,
- Narrow Red Sea coastal plain of Tertiary and Quaternary sedimentary rocks and coral reefs the Red Sea coastal plain.

In addition to these divisions, Vincent (2008) identifies the two major sand seas (i.e. Rub' al Khali and An Nafud) as a fifth geological division. These sand seas are located on the Arabian Shield.

Figure 7-1: Geological Divisions of Saudi Arabia (Source: Saudi Geological Survey, 2016)

The sedimentary rocks to the east and north of Precambrian Arabian Shield cover almost two-thirds of the total land mass of Saudi Arabia. The younger rocks in Saudi Arabia belong to the Paleozoic (540-250 million years), Mesozoic (250-65 million years), and Cenozoic (65 million years to Recent) (collectively referred to as Phanerozoic cover), and crop out as relatively flat lying beds of sedimentary rocks such as sandstone, siltstone, limestone, and evaporates (salt deposits), and volcanic rocks. The youngest deposits in the region include coral limestone and unconsolidated sand, silt, gravel, and sabkha, which accumulated in the sand seas of Ar Rub al Khali and An Nafud, filled dried-up lake beds and wadis, and fringed the coastlines.

The development site is located on the Arabian Platform (Figure 7-2). The Phanerozoic Arabian platform is comprised of cover rocks of clastic, calcareous and evaporitic successions dipping gently eastward away from the Arabian shield (Figure 7-2- www.sgs.org.sa). These sedimentary successions cover almost two-thirds of the total area of Saudi Arabia (Vincent, 2008). The Phanerozoic cover rocks of the Arabian Shield belong to the Paleozoic (540-250 Ma), Mesozoic (250-65 Ma), and Cenozoic (65 Ma to Recent), and crop out as relatively flat lying beds of sedimentary rocks such as sandstone, siltstone, limestone, and evaporites (salt deposits), and volcanic rocks. The rocks were deposited uncomfortably on the underlying Precambrian basement, in riverbeds, in glacial valleys, and in shallow seas, or were extruded from subaerial volcanoes (www.sgs.org.sa).

The youngest deposits in the region include coral limestone and unconsolidated sand, silt, gravel, and sabkha, which accumulated in the sand seas of Ar Rub al Khali and An Nafud, filled dried-up lake beds and wadis.

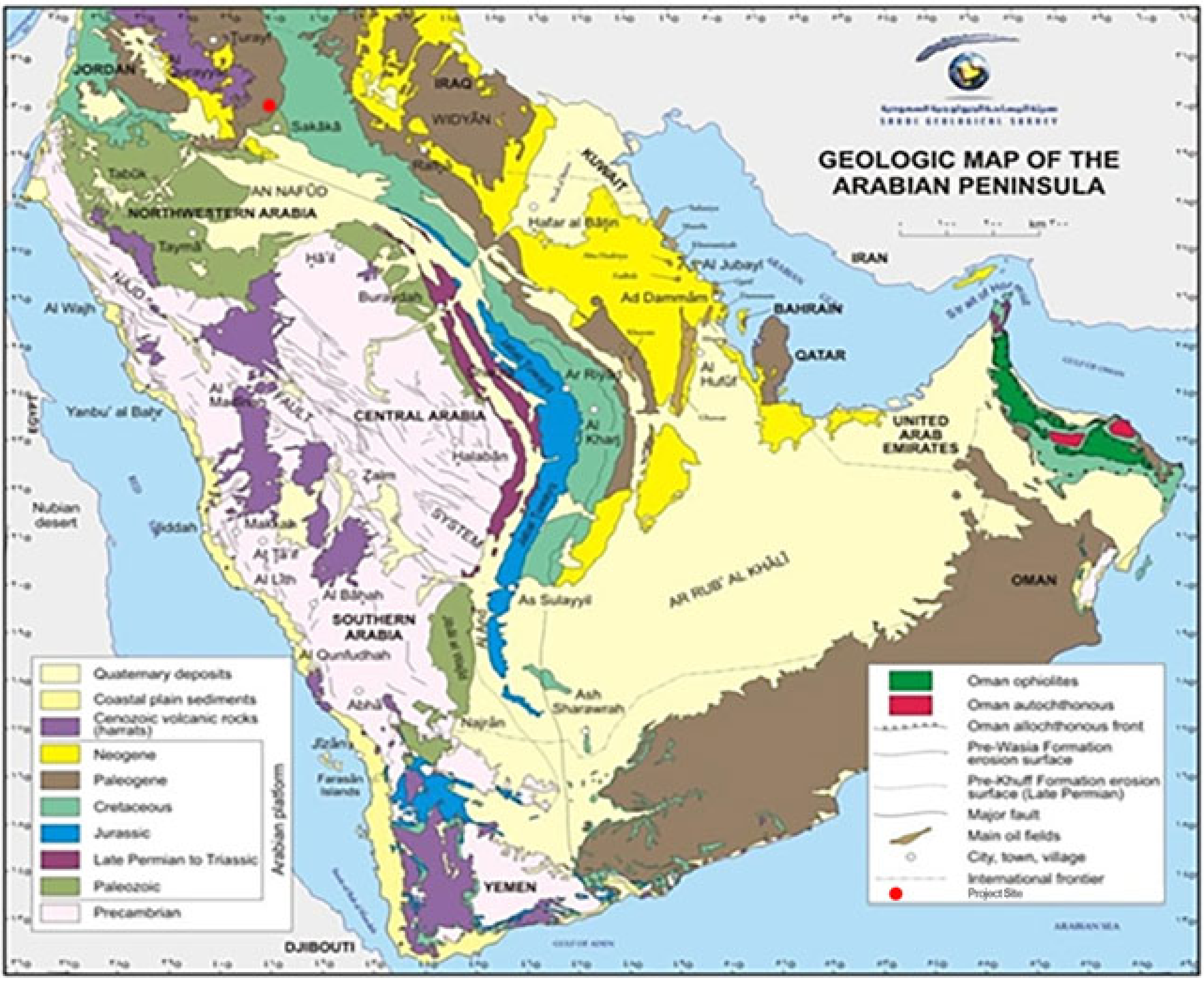

Figure 7-2: Geologic Map of the Arabian Peninsula (Source: www.sgs.org.sa)

7.3.1.2 Regional Soils

The Saudi Geological Society has developed a series of surface geology maps for the Kingdom of Saudi Arabia, published by the former Ministry of Petroleum and Mineral Resources, now the Ministry of Energy, Industry and Mineral Resources. Sheet 29d covers the Al Jawf Quadrangle, within which the development site is located. Figure 7-3 shows an extract of sheet 29d.

The extract of Sheet 29d illustrates that the surface geology within the approved Land Use Permit is predominantly comprised of two types:

- Jauf Formation (Dj): Cream, tan, and gray, finely crystalline Limestone with dolomitized algal zones at several levels, inter bedded with gray-green, red, Silty Shale.
- Aruma Formation (Ka): Gray, buff, white, and tan Limestone, Marly Limestone, and dolomite with light gray, buff, yellowish brown dolomitic Marl, Shaly Marl and Chalky Limestone.

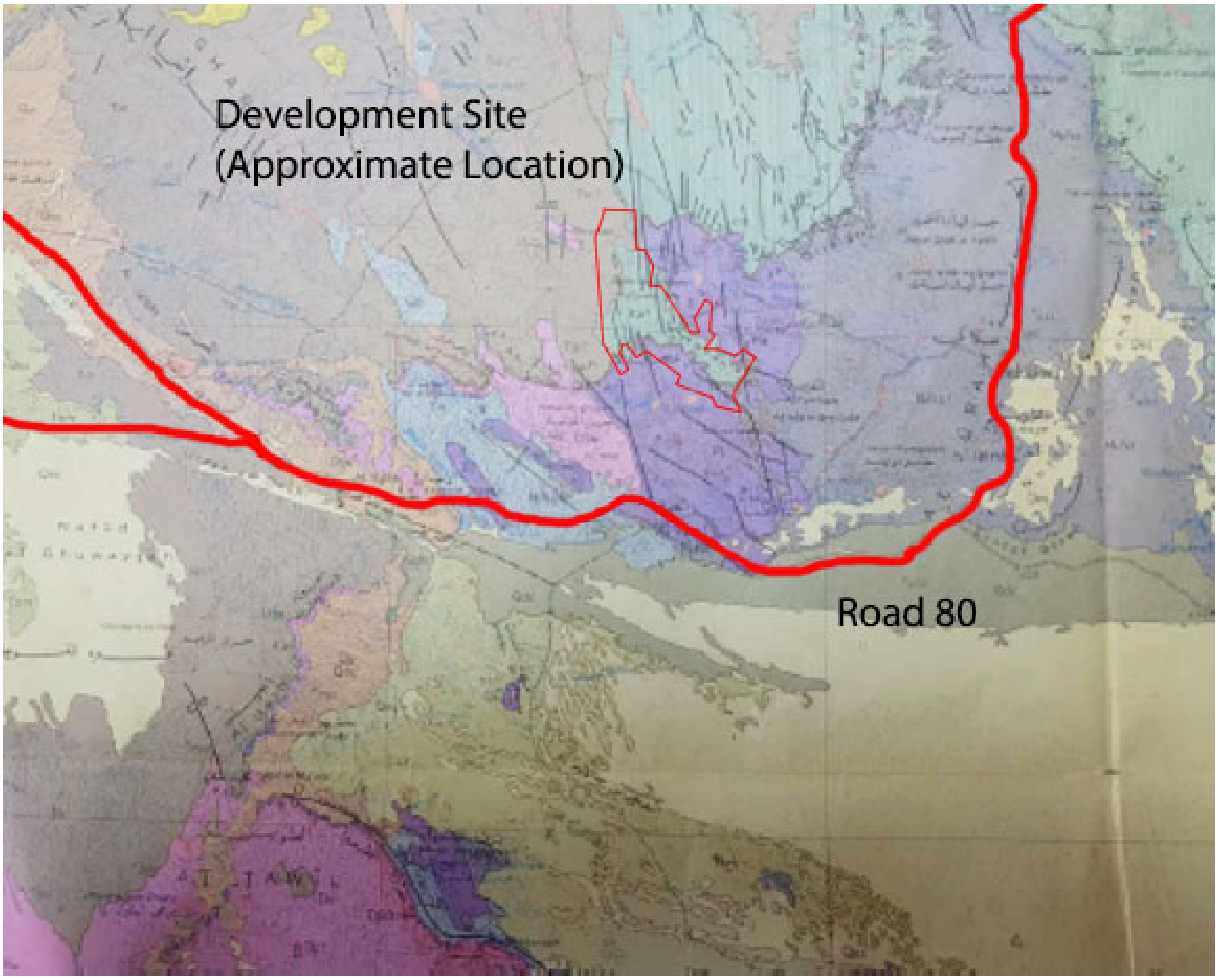

Figure 7-3: Extract from Geology Map of Saudi Arabia

The soils at the development site are classified as Torriorthents-Calciorthids-Rock Outcrop. This soil is described as *'the most extensive soil association in Saudi Arabia and has been mapped over vast areas of the eastern Shield and crystalline Nadj. The Calciorthids are located in the interfluve areas and footslopes and are sometimes intricately mixed with exposed bedrock. The Torriothents are often found on large gravel fans where widyan debouch from mountainous confines. This association mainly supports rangeland. There is some irrigated agriculture where rock outcrops are not too numerous'* (Vincent, 2008).

7.3.2 Local Geology and Soils

A geotechnical survey for the Park was commissioned and, undertaken by Arab Company for Laboratories and Soil. A total of ten boreholes were drilled between the 5th December 2016 and 10th January 2017. The boreholes were drilled up to 30 m depth or 10 m within intact rock (whichever was less below the existing ground level). Figure 7-4 shows the borehole locations.

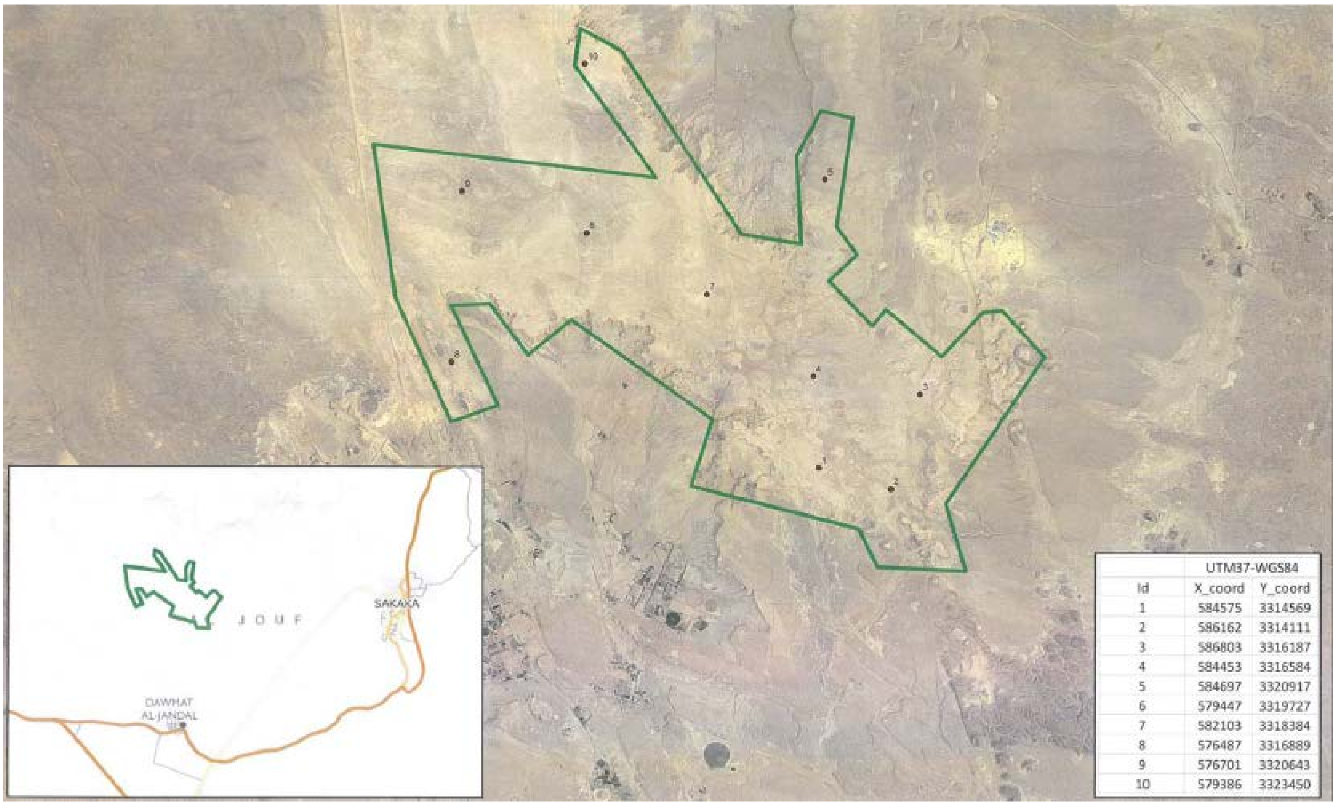

Figure 7-4: Borehole Locations

The drilling of boreholes was carried out using Ardco drilling rigs mounted on Mercedes trucks, using the rotary air flush drilling method. The following *in-situ* tests were conducted as part of the geotechnical investigation:

- Ten (10) cross-hole seismic tests to estimate the dynamic properties of the soil for designing the dynamic vibrated turbine foundations including drilling for the test were performed.
- Ten (10) seismic refraction tests for evaluating rock rippability in case of potential excavation e.g. foundation excavations were performed.

Core samples were examined in situ and sent to a laboratory for further testing. Laboratory tests carried out included:

- Classification and index tests: moisture content;
- Strength tests: Unconfirmed compressive strength; and,
- Chemical tests: Sulfate, Chloride, pH and Calcium Carbonate.

The soil encountered in the boreholes is generally very dense. The rock encountered in the boreholes is generally very weak to medium strong, moderately to highly fractured and moderately to highly weathered (ACES, 2017). The pertinent features of the subsurface stratigraphy encountered at the site are summarized in Table 7-1 below.

Table 7-1: Subsurface Material

Borehole No.	Depth (m) bgl	Thickness of layer (m)	Type of Material	UCS (Mpa)	Density / Strength
BH-01 BH-03 BH-04 BH-05 and	(0.0 – 0.4)	0.4	Residual Soil	-	Very Dense
	(0.0 – 0.4) – (12.0 – 16.5)	12.0 – 16.5	Jauf Formation	2.32	Very Weak to Medium Strong

Borehole No.	Depth (m) bgl	Thickness of layer (m)	Type of Material	UCS (Mpa)	Density / Strength
BH-08					
BH-02 BH-06 BH-07 BH-09 and BH-10	(0.0 – 0.4)	0.4	Residual Soil	-	Very Dense
	(0.0 – 0.4) – (12.0 – 16.5)	12.0 – 16.5	Jauf Formation	2.35	Very Weak to Medium Strong

The geologic profiles of the boreholes and surface and subsurface ground materials in the study area can be divided into the following types: residual soil, limestone, sandy marlstone, chalky limestone, quartzite and marly limestone. The surface and subsurface ground materials for the boreholes are summarized in Table 7-2, and the geological profiles of representative boreholes are illustrated in Table 7-3, Table 7-4, Table 7-5, Table 7-6 and Table 7-7. No ground water was encountered at the site.

Table 7-2: Soil and Rock Formation with approximate boundaries

Borehole	Residual Soil	Limestone	Sandy Marlstone	Chalky Limestone	Quartzite	Marly Limestone
	Depth Range in Meter below existing ground level					
BH-01	0.0 – 0.4	0.04 – 7.5	7.5 - 15	-	-	-
BH-02	-	-	1.5 – 16.5	0.0 – 0.15	-	-
BH-03	-	0.0 – 6.0	6.0 – 15.0	-	-	-
BH-04	-	-	6.0 – 16.5	0.0 – 6.0	-	-
BH-05	-	0.0 – 9.0	9.0 – 12.0	-	-	-
BH-06	-	1.5 – 12.0	-	-	-	0.0 – 1.5
BH-07	-	-	9.0 – 13.5	0.0 – 9.0	-	-
BH-08	-	0.0 – 13.5	-	-	-	-
BH-09	-	-	12.0 – 13.0	4.5 – 12.0	0.0 – 4.5	-
BH-10	0.0 – 0.4	0.4 – 4.5	4.5 – 15.0	-	-	-

Table 7-3: Borehole 1 Results

Depth	Description
0.3	Very dense, brown, fine to medium grained, Silty SAND with Gravel
0.6	Weak, light creamy white to yellow limestone, interbedded with dolomitic at some places, very thick bedded, moderately spaced joint, slightly weathered, slightly fractured @TCR=65 %, SCR=26 %, RQD=18 %.
7.9	Weak, light yellowish to dark maroon, Sandy Marlstone, moderately spaced joints, very thick bedded, slightly weathered, slightly fractured @TCR=84 %, SCR=24 %, RQD=18 %.
15	End of Boring

Table 7-4: Borehole 3 Results

Depth	Description
6.1	Weak, light creamy white to yellow, LIMESTONE, very thick bedded, widely spaces joint, moderately weathered, moderately fractured. @TCR=53 %, SCR=15 %, RQD=15 %
	Very weak, dark greenish yellow, sandy MARLSTONE interbedded with chalky LIMESTONE, very thick bedded, closely spaces joint, slightly weathered, slightly fractured. @TCR=86 %, SCR=50 %, RQD=26 %
15	End of boring

Table 7-5: Borehole 5 Log

Depth	Description
8.8	Weak, light creamy to yellow, Limestone, widely spaced joint, very thick bedded, slightly weathered, slightly fractured. @TCR=80 %, SCR=8 %, RQD=0 %
12 (End of Boring)	Weak, light reddish brown, Sandy MARLSTONE, closely spaced joint, very thick bedded, slightly weathered, slightly fractured @TCR=100 %, SCR = 66 %, RQD = 45 %.

Table 7-6: Borehole 7 Log

Depth	Description
8.8	Weak, light creamy white, Chalky LIMESTONE, very thick bedded, widely spaced joint, highly weathered, highly fractured @TCR=40 %, SCR=0 %, RQD=0 %.
13.5 (End of Boring)	Weak, light greenish grey to reddish, Sandy MARLSTONE, very thick bedded, widely spaced joints, slightly weathered, slightly fractured @TCR=70 %, SCR=6 %, RQD=0 %

Table 7-7: Borehole 9 Log

Depth	Description
4.6	Weak, light creamy white to grey, QUARTZITE, very thick bedded, moderately to widely spaced joint, highly weathered, highly fractured. @TCR=51 %, SCR=0 %, RQD=0 %.
12.2	Weak, light creamy golden brown, chalky LIMESTONE interbedded with MARLSTONE, very thick bedded, closely spaced joint, slightly weathered, slightly fractured. @TCR=79 %, SCR=64 %, RQD=41 %
13 (End of Boring)	Weak, dark reddish to golden brown SANDY MARLSTONE, thick bedded, closely spaced joint, slightly weathered, slightly fractured @TCR=100 %, SCR=78 %, RQD=12 %

7.3.3 Quality and Contamination

The site is undeveloped and there is no evidence of any significant historic land uses (e.g. agricultural, commercial, industrial). The full site was accessed and surveyed and there is no evidence of historic or recent contamination within the developable area of the Park. Similarly, no potential sources of contamination have been identified adjacent to the Park.

7.3.4 Load Bearing Capacity and Backfill

The strata at the development site are identified as being suitable to accommodate the anticipated loads of turbines and foundations. Some cut and fill is anticipated at the development site in order to accommodate the installation of the wind turbines.

The soils and geology report (ACES, 2017) additionally makes the following recommendation: *'Since the encountered material in BH-02 at depth of foundation is Marlstone, we recommend replacing 0.5 m of Marlstone layer with crushed gravel grading from 50 mm to 150 mm.'*

7.4 Assessment Methodology

7.4.1 Approach

The development of the Park may result in potential impacts to the soils and geology of the development site during the construction, commissioning, operation and decommissioning/ closure phases of the Park. Accidental events may also result in potential impacts.

The significance of potential impacts on soils and geology has been assessed and where appropriate, mitigation measures identified and the resulting residual impacts evaluated. The assessment of impacts on quality of soil has been undertaken on the basis of a Source-Pathway-Receptor approach.

The assessment of surface and ground water impacts is provided in Chapter 8 – *Hydrology and Hydrogeology.* Any groundwater input to surface water flows, primarily in the minor wadi flow channels, during rainfall events, will be ephemeral and relate solely to the rainfall event. This eventuality is therefore considered part of the surface water assessment and not discussed in this chapter. Chapter 11 - *Terrestrial Biodiversity* provides the full ecology assessment and discusses impacts related to the ecological habitats of minor wadi flow paths and ecosystem services (i.e. regulating services). .

The storage and handling of non-hazardous and hazardous materials and wastes generated during all phases of the Park may lead to spillages and releases which could impact the soils and geology of the development site if not adequately managed. A detailed assessment of waste management is presented in Chapter 16 - *Waste Management*. These aspects are not assessed in this section.

The magnitude and significance of impacts are assessed and defined according to the criteria presented in chapter five of this report. Each impact is identified by a unique reference number (in the format "SG#") in the impact assessment and mitigation sections.

7.5 Impact Assessment

7.5.1 Construction Phase

Construction phase impacts are those expected to occur during the construction of the Park. These include impacts resulting from dust damping, storage of hazardous and non-hazardous materials and leaks from poorly maintained equipment. Table 7-8 shows impacts expected to occur during the construction phase of the Park.

The IPP must prepare an Environmental Management and Monitoring Plan, within which will be a Construction Environmental Management Plan (CEMP). The purpose of the CEMP is to manage environmental and social risk, as part of its Environmental and Social Management System (ESMS), in compliance with IFC Performance Standard 1. The CEMP will describe the environmental management and monitoring procedures to be implemented during the construction phase of the Park, will ensure that appropriate environmental management practices are followed during the construction phase, and that potential impacts on soils and geology are avoided.

Implementation of the CEMP will ensure:

- Compliance with conditions of authorizations, resource consents, and designations;
- Awareness of and adherence to environmental objectives;
- Proper management of environmental risks associated with the Park;
- Maintenance of competence and training requirements of staff with environmental responsibilities;
- Lines of communication in the event of an emergency;

- Construction waste management plan, designed to eliminate the risk of contamination entering the natural environment;
- Identification and control of wastewater discharges, in particular the sanitary wastewater discharges from the temporary construction site offices;
- Ensure that all substances are stored in suitable, undamaged, containers; clearly marked with the type, nature and content of the material, to ensure that all staff are aware of the material and its properties;
- Ensure the availability of pumps and spill mitigation materials such as absorbent granules, to contain and recover hazardous substance releases; and,
- Procedure to be implemented following the accidental release of hazardous substances during refueling of vehicles, including details of containment and recovery measures to be applied.

Table 7-8: Construction Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
SG1	Soil/Geology	Low	Contamination of soils by aqueous discharges, spills and leaks	Effect: Negative Action: Direct Likelihood: Likely Frequency: Frequent Duration: Short Extent: Local Permanence: Reversible	Moderate	Low
SG2	Soil/Geology	Low	Loss of potential future land use.	Effect: Negative Action: Direct Likelihood: Certain Frequency: Continuous Duration: Medium Extent: Local Permanence: Reversible	Moderate	Low
SG3	Soil/Geology	Low	Alteration of existing topography	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Continuous Duration: Medium Extent: Local Permanence: Reversible	Moderate	Low
SG4	Soil/Geology	Low	Risk of leaks arising from the use of poorly maintained construction plant and equipment	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Rare Duration: Medium Extent: Local Permanence: Reversible	Moderate	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
SG5	Soil /Geology	Low	Loss of soils through wind blown erosion	Effect: Negative Action: Direct Likelihood: Likely Frequency: Infrequent Duration: Short Extent: Local Permanence: Reversible	Moderate	Low

7.5.1.1 Contamination of soils by aqueous discharges, spills and leaks

During the construction phase of the project, there is potential for a range of aqueous discharges, spills and leaks. The uncontrolled discharge of aqueous effluents from construction activities has the greatest potential to adversely impact soil resources within the developable area of the Park. Activities include the washing down of equipment, dust damping, concrete work, washout from the concrete batching plant and the wash-out from concrete trucks which is highly alkaline. Excluding dust damping, these activities will only be undertaken within designated areas where wastewater management and containment systems are installed and operational to comply with Section 1.3 *Wastewater and Ambient Water Quality* of the IFC EHS Guidelines and GAME Environmental Standard for *Industrial and Municipal Wastewater Discharges*.

The washout from cement mixers and the dry mix batching plant will be discharged to a designated containment and evaporation pond. Evaporation of the water content of this waste stream will facilitate the recovery and recycling of concrete in fill or foundations.

Sanitary wastewater from the construction camp will be temporarily stored in a septic tank, and transferred to a municipal wastewater treatment system by suction tanker. The sanitary wastewater system will be adequately designed and sized to accommodate volumes of approximately 58 m^3 from a maximum sized workforce of 180 people. The design of the sanitary wastewater system will be in compliance with Section 1.3 *Wastewater and Ambient Water Quality* of the IFC EHS Guidelines and GAME Environmental Standard for *Industrial and Municipal Wastewater Discharges.*

There will be a requirement for storage of hazardous liquids (i.e. diesel fuel for generators) and other materials on site for the duration of the construction phase. Diesel fuel will be stored in an above ground tank with secondary containment in accordance with Section 1.5 *Hazardous Materials Management* of the IFC EHS Guidelines. Other fluids including lubricating oils and hydraulic fluids will similarly be stored with adequate secondary containment. Hazardous materials will be stored in accordance with the specifications on the Material Safety Data Sheets to ensure appropriate container materials are used, and environmental conditions are managed (e.g. shading, temperature control). These measures will manage the risk of accidental leaks and spills and run-off during times of rainfall.

Re-fueling of vehicles and other fluid transfers will only take place in designated areas where there are impervious surfaces. Where hard surfaces have the potential to collect fluids with the potential to impact upon soils or geological resources, (such as car parks or fuel storage areas), oil interceptors should be utilized as per the requirements of GAME Environmental Standard 6 - Storage and Material Reclaim Facilities Design and Operation. This will prevent the introduction, through infiltration of any harmful fluids into groundwater and hydrological resources.

Dust damping using water will be kept to a minimum to reduce water consumption and safeguard this resource. This approach is considered appropriate based on the absence of sensitive human receptors in proximity to construction activities. If there is a requirement for dust damping, such as at locations where the workforce would be in proximity to sources of dust particles, water will be supplied by tanker and achieve the 2006 standards for wastewater reuse in agricultural irrigation issued by the Ministry of Water and Electricity (MWE). Although not directly relevant to dust control, compliance with these standards will ensure the water sourced will not result in contamination or salination of soils. The MWE standards are more stringent than the WHO standards. Wherever practicable this water will be sourced from local sewage treatment plants which conform to the GAME standards for discharge limits.

The Construction Phase Environmental Management Plan will contain an Environmental Emergency Response Plan that will include detailed instructions regarding cleanup of spills, as laid out in the GAME (PME) Environmental Rules and Regulations for Implementation and IFC performance Standard 1, Paragraph 20 *Emergency Preparedness and Response.* Based on the assumption that the management and storage of aqueous liquids will be in accordance with IFC and GAME standards, potential impacts are predicted to be temporary and localized. This impact is considered to be of low significance.

Impact SG1 – Low Significance

7.5.1.2 Loss of potential future land use

The change in land-use associated with the development of the Park has the potential to impact on future land uses and the value of natural resources, for example the loss of soil resources and impairment of agricultural land. However the developable area is predominantly comprised of a raised and exposed plateau and the site as a whole is not currently considered to be high value for grazing or agriculture and is therefore considered to have low sensitivity to this potential impact.

Although camels have been recorded in the vicinity of the project, animals have only been observed in low numbers and there is no evidence of seasonal herders establishing transient camps and livestock holding areas. Due to the scale of the development, security fencing will only be installed around the construction camps and storage areas and it is expected that the rest of the developable area will remain open. Camels will likely remain free to graze vegetation within the developable area.

A further potential impact of soil compaction has the capacity to impact on the value of land uses. As stated previously however, the soil resource is not of high value and the surface geology of the site in the location of the turbines and lifting pads (i.e. residual soils overlying bedrock) limits the degree of compaction that might occur.

Additionally, at closure and decommissioning, the land could be returned to its original use. Therefore, due to the reversible nature of this impact, it is assessed as being of low significance.

Impact SG2 – Low Significance

7.5.1.3 Alteration of existing topography

Construction activities will include pre-construction site clearance and grading prior to the installation of operational infrastructure. Based on the relatively uniform topography of the developable area, and the localized impacts of construction activities, these activities are not anticipated to be extensive and this impact is assessed as being of low significance.

Impact SG3 – Low Significance

7.5.1.4 Risk of leaks arising from construction plant and equipment

Throughout the assessment, it is assumed that plant used by the contractor on site will be within its design life, and has been properly maintained as per the manufacturer's instructions. Where plant is expired, or has not been properly maintained, there is a potential for uncontrolled leaks and spills arising from cracked fuel units, faulty pipes and other mechanical failures.

Fuels will be stored in accordance with the guidelines in Section 1.5 of the IFC General EHS Guidelines, including secondary containment systems. Vehicle refueling should be undertaken within an area of concrete hard-standing with spill containment and all stationary plant should have drip trays installed.

The Construction Phase Environmental Management Plan will contain an Environmental Emergency Response Plan which will include detailed instructions regarding cleanup of spills, as laid out in the GAME (PME) Environmental Rules and Regulations for Implementation and IFC performance Standard 1, Paragraph 20 *Emergency Preparedness and Response.*

Due to the fact that the volumes of material which could potentially escape in this scenario are small, and the fact that the impact would be localized, this impact is considered to be of low significance.

Impact SG4 – Low Significance

7.5.1.5 Erosion of Soils

There is a potential for the loss of soils through windblown disturbance. When soil is disturbed through construction activities such as vehicle movements, site grading and excavation, wind can displace this soil and carry it elsewhere on the site. Such activity can lead to a loss of soil resources and the nutrients within the soil.

Particles can be displaced and transported by wind in a number of ways, dependent on the size of the particles and the speed of the wind. Larger particles require greater wind speed to be displaced. Particles of ~100 μm are the most susceptible to 'wind drag' and can be moved by low wind speeds. These particles will typically 'hop' along the surface of the ground in what is known as 'saltation'. These 'saltators' can mobilize particles of a wide range of sizes. Dust particles are not normally directly lifted by wind because their inter particle cohesive forces are large compared to aerodynamic forces. Small particles are elevated from the soil as a result of impact from the saltating particles. Following ejection, dust particles are susceptible to turbulent fluctuations and usually enter short-term (~ 20 – 70 mm diameter) or long-term (< ~20 mm diameter) suspension. Long-term suspended dust can remain in the atmosphere for several weeks and be transported thousands of kilometers from its source. The acceleration of particles with diameters in excess of ~500 μm is limited by their size and resultant inertia. These particles generally do not saltate, they usually settle into the soil after moving generally less than a centimeter (reptation). Larger particles can roll or slide along the surface, driven by saltating particles and wind drag forces in a mode of transport known as creep. Creep and reptation can account for a substantial fraction of the total wind-blown sand flux.

The transport of soil particles by wind can thus be crudely separated into several physical regimes: long-term suspension (< ~20 μm diameter), short-term suspension (~20 – 70 μm), saltation (~70–500 μm), reptation and creep (> ~500 μm). Note that these four transport modes are not discrete: each mode morphs continuously into the next with changing wind speed, particle size, and soil size distribution.

During storm events, there is potential risk for soil erosion of disturbed areas and wash-out. As reported by AECOM (2016) in the Dumat Al Jandal Wind Farm Development Hydrology and Flood Risk Assessment report, the material found in and around the wind farm site is potentially erodible during flood events. Based upon the observed composition of the ground material, it is likely that these materials will begin to be eroded in flood flow velocities between 0.5 m/s to 1 m/s. There is potential for scour and erosion during the construction phase of the Park.

Based on the negligible soil resource across the development area, the potential for loss of soil through wind-blown disturbance is considered to be of low significance. Based on the assumption that construction activities will avoid known minor wadi flow paths as far as practicable, the loss of soils through disturbance and erosion during periods of rainfall and overland flows is assessed as negligible.

Impact SG5 – Low Significance

7.5.2 Operation Phase Impacts

Operational phase impacts are those expected to occur during the day to day operation of the Park. These include impacts resulting from improper storage of materials, discharges from vehicles and runoff from surfaces. Table 7-9 shows impacts expected to occur during the operational phase of the Park.

Table 7-9: Operational Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
SG6	Soil/Geology	Low	Loss of soil resource due to modification of minor wadi flow paths	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Rare Duration: short Extent: Local Permanence: Reversible	Low	Low
SG7	Soil/Geology	Low	Loss of soil due to storm water runoff and erosion	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Rare Duration: short Extent: Local Permanence: Reversible	Low	Low
SG8	Soil/Geology	Low	Accidental leaks and spills	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Rare Duration: short Extent: Local Permanence: Reversible	Low	Low

7.5.2.1 Loss of soil resource due to modification of minor wadi flow paths

The development of the Park has the potential to contribute towards a loss of soil resources and increase scour and erosion though modification of surface water flows. A detailed hydrology and flood risk assessment study has been undertaken by AECOM (2016), and this has identified that velocities within some flow routes are sufficient to impact on the proposed wind turbine locations and the integrity of the access tracks. This is based on the preliminary design and turbine layout configuration.

The report identifies measures to alleviate flood risk and impacts on existing flow routes, which will contribute towards safeguarding the integrity of infrastructure and avoidance of scour and erosion. This includes the repositioning of turbines to avoid flow routes etc.

The preliminary design includes a reinforced cross-section for the access tracks to the south of the Park where there is a risk from flooding. Based on the implementation of the recommended design measures in the AECOM (2016) hydrology and flood risk assessment report, it is assessed that significant impacts will be avoided and the risk of scour and erosion and modification of flow routes is therefore considered to be low significance.

Impact SG6 – Low Significance

7.5.2.2 Loss of soil due to storm water runoff and erosion

AECOM (2016) has determined that the material found in and around the wind farm site is potentially erodible during flood events. This is the base case scenario. Based upon the observed composition of the ground material, it is likely that these materials will begin to be eroded in flood flow velocities between 0.5 m/s to 1 m/s. The potential for ground material to be mobilized during the operational phase of the Park remains the same in flood flow velocities between 0.5 m/s to 1 m/s.

The Dumat Al Jandal Wind Farm Development Hydrology and Flood Risk Assessment report has recommended design measures to avoid impacts of scour and erosion, and modification to flow routes. Subject to the implementation of these measures, it is not predicted that storm water run-off and erosion will significantly differ to the base case scenario. This impact is considered to be of low significance.

Impact SG7 – Low Significance

7.5.2.3 Impact on soil from release of stored chemicals/fluids on site

During the operational phase of the project there will be no permanent workforce on site, however the substation structures may provide limited storage facilities, including a septic tank. The sanitary wastewater system for the substations will be adequately designed and sized; and the design of the system will be in compliance with Section 1.3 *Wastewater and Ambient Water Quality* of the IFC EHS Guidelines and GAME Environmental Standard for *Industrial and Municipal Wastewater Discharges.* In addition, the septic tank will have secondary containment in accordance with Section 1.5 *Hazardous Materials Management* of the IFC EHS Guidelines.

Where septic wastes are stored on site during the operation of the Park, there is a potential for uncontrolled releases to the soils of the development site. Waste will be stored in a double bunded (to 110 % capacity) tank.

Due to the absence of a permanent operational workforce on site, and the negligible risk of damage caused to soils by sanitary waste, this impact is considered low significance.

Impact SG8 – Low Significance

7.5.3 Decommissioning Phase Impacts

The impacts associated with the decommissioning of the wind energy park are anticipated to be similar to those expected to occur during the construction phase. See section 7.5.1 for details. One further impact is predicted and this is described in Table 7-10 and section 7.5.3.1below.

Table 7-10: Decommissioning Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
SG9	Soil/Geology	Low	Contamination of soils with demolition waste	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Rare Duration: short Extent: Local Permanence: Reversible	Low	Low

7.5.3.1 Contamination of soils with demolition waste

Following decommissioning of the Park, there is a potential for inert demolition waste and materials (e.g. broken-out concrete foundations, steel reinforced tubular bars, aggregate material used in road construction, cabling etc.) to contaminate soils and impair future land uses.

In particular, the decommissioning of the transformers and sub-stations has the potential for spills and leaks of transformer and insulating oils. Transformer oil is classified as a hazardous waste and this must be disposed of by a fully licensed and approved waste management contractor and facility. Prior to decommissioning, all oils should first be drained. This will minimize the risk for accidental spills and leaks during removal from the site and transit of equipment for disposal.

All demolition work will be carried out with reference to IFC EHS Guidelines 1.6 *Waste Management* and the GAME (PME) Environmental Standard 18 *Best Practicable Environment Option for Waste Disposal,* this will include the identification of opportunities for recycling of inert construction wastes where possible, and reuse of these wastes on nearby or similar sites.

As part of the overall decommissioning plan, a decommissioning waste management plan will be prepared by the contractor in accordance with IFC requirements. This plan will include details of how wastes will be handled and the details of licensed disposal facilities to be used. Due to the inert nature of the waste expected to be generated during the decommissioning of the Park, the significance of this impact is considered to be low.

Impact SG9 - Low Significance

7.6 Mitigation and Recommendations

7.6.1 Construction Phase

Impacts anticipated during the construction phase of the Park are expected to be of low significance therefore no mitigation is proposed. In order to ensure the implementation of best practice during construction and decommissioning, the following best practice recommendations are advised;

It is advised that maintenance and lifespan requirements of plant and other vehicles to be used on site are laid out in advance of construction. This will allow the contractor sufficient time to perform proper maintenance and upkeep on required plant in advance of construction.

7.6.2 Operation Phase

Impacts anticipated during the operation phase of the Park are expected to be of low significance and no additional measures are required.

7.6.3 Decommissioning Phase

Impacts associated with decommissioning are expected to be similar to those experienced during construction and as such, no further measures are recommended. A Decommissioning Plan will be included within the Environmental Monitoring and Management Plan which will detail methods for disposal of decommissioning wastes.

During the decommissioning of the Park, a significant amount of concrete will be broken out and will require disposal, in addition to other demolition materials. These materials should be managed in accordance with the waste management hierarchy (refer to Chapter 16 *Waste Management*). Potential uses for concrete foundations include:

- Sub base layer in new road projects; and,
- Aggregate for new construction projects.

Potential reuse of this material should be discussed with stakeholders and local Amana as part of the Stakeholder Engagement Plan and a decommissioning waste management plan.

7.7 Conclusion

It is not anticipated that the Dumat Al Jandal Wind Energy Park will have a significant impact upon the soil and geology of the development site, or that of the surrounding area. Where impacts are anticipated, they are expected to be of low significance, and are fully reversible upon decommissioning of the Park.

7.8 References

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8. Hydrology & Hydrogeology

8.1 Introduction

This chapter provides an overview of the existing hydrological and hydrogeological conditions present at the development site, and an evaluation and assessment of the potential impacts upon them which may arise as a result of the development of the Dumat al Jandal Wind Energy Park (the 'Park').

The assessment addresses regional and local hydrological and hydrogeological conditions, characterizes the surface and ground water resources and quality, and assesses potential impacts on receptors. Impacts related to the supply of municipal, potable and sanitary water are addressed in Chapter 15 *Utilities and Infrastructure*.

8.2 International and National Standards and Guidance

8.2.1 IFC EHS Guidelines

Section 1.3 Wastewater and Ambient Water Quality of the IFC EHS Guidelines (2007) applies to projects that have either direct or indirect discharge of process wastewater, wastewater, wastewater from utility operations or storm water to the environment; and includes measures for water conservation and reuse. The standard states that projects with the potential to generate process wastewater, sanitary (domestic) sewage, or storm water should incorporate the necessary precautions to avoid, minimize, and control adverse impacts to human health, safety or the environment. Section 1.4 *Water Conservation* of the IFC EHS Guidelines (2007) outlines recommendations for the implementation of water conservation programs across all projects with a potential to use large quantities of water for any purpose. The recommendations include:

- Storm/Rainwater harvesting and use;
- Zero discharge design/Use of treated waste water to be included in project design processes;
- Use of localized recirculation systems in plant/facility/shops (as opposed to centralized recirculation system), with provision only for makeup water;
- Use of dry process technologies e.g. dry quenching;
- Process water system pressure management;
- Project design to have measures for adequate water collection, spill control and leakage control system.

Section 3: *Community* of the IFC EHS Guidelines (2007) states that "Drinking water sources, whether public or private, should at all times be protected so that they meet or exceed applicable national acceptability standards or in their absence the current edition of WHO Guidelines for Drinking-Water Quality."

Section 4: *Construction* of the same document covers soil erosion, disturbance to water bodies and other impacts associated with construction. It states the following:

"Soil erosion may be caused by exposure of soil surfaces to rain and wind during site clearing, earth moving, and excavation activities. The mobilization and transport of soil particles may, in turn, result in sedimentation of surface drainage networks, which may result in impacts to the quality of natural water systems and ultimately the biological systems that use these waters. Recommended soil erosion and water system management approaches include:

- *Depending on the potential for adverse impacts, installing free-spanning structures (e.g., single span bridges) for road watercourse crossings;*
- *Restricting the duration and timing of in-stream activities to lower low periods, and avoiding periods critical to biological cycles of valued flora and fauna (e.g., migration, spawning, etc.);*
- *For in-stream works, using isolation techniques such as berming or diversion during construction to limit the exposure of disturbed sediments to moving water; and,*
- *Consider using trenchless technology for pipeline crossings (e.g., suspended crossings) or installation by directional drilling*".

The IFC EHS Guidelines (2007) provide guidelines for the management of wastewater, liquid effluent quality (including the discharge to surface water and sanitary sewer systems, land application of treated effluent and septic systems), and storm water management and also lays out the requirements for the consideration of capacity within receiving water.

8.2.2 IFC Performance Standard 3

Performance Standard 3 recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. Resource efficiency is the central tenet of this standard, and implementing technical and financially feasible and cost effective measures for improving efficiency in consumption of energy, water as well as other resources and material inputs (IFC, 2012).

The objectives for this Performance Standard are as follows:

- To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities;
- To promote more sustainable use of resources, including energy and water; and,
- To reduce project-related Greenhouse Gas (GHG) emissions.

As stated in IFC Performance Standard 3, "w*hen the project is a potentially significant consumer of water, in addition to applying the resource efficiency requirements of this Performance Standard, the client shall adopt measures that avoid or reduce water usage so that the project's water consumption does not have significant adverse impacts on others. These measures include, but are not limited to, the use of additional technically feasible water conservation measures within the client's operations, the use of alternative water supplies, water consumption offsets to reduce total demand for water resources to within the available supply, and evaluation of alternative project locations"*.

8.2.3 IFC Performance Standard 4

Performance Standard 4 recognizes that project activities, equipment, and infrastructure often bring benefits to communities including employment, services, and opportunities for economic development. However, projects can also increase the potential for community exposure to risks and impacts arising from equipment accidents, structural failures, and releases of hazardous materials. Communities may also be affected by impacts on their natural resources, exposure to diseases, and the use of security personnel. While acknowledging the public authorities' role in promoting the health, safety and security of the public, this Performance Standard addresses the client's responsibility to avoid or minimize the risks and impacts to community health, safety and security that may arise from project activities. The level of risks and impacts described in this Performance Standard may be greater in projects located in conflict and post-conflict areas (IFC, 2012).

The objectives of this Performance Standard are as follows:

- To avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances.
- To ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security.

As stated in IFC Performance Standard 4, *"The client will also avoid or minimize adverse impacts due to project activities on soil, water, and other natural resources in use by the affected communities"*

8.2.4 IFC Performance Standard 6

Performance Standard 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The requirements set out in this Performance Standard have been guided by the Convention on Biological Diversity, which defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems."

The objectives of this Performance Standard are as follows:

- To protect and conserve biodiversity.
- To maintain the benefits from ecosystem services.
- To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

As stated in IFC Performance Standard 6: *"The risks and impacts identification process as set out in Performance Standard 1 should consider direct and indirect project-related impacts on biodiversity and ecosystem services and identify any significant residual impacts. This process will consider relevant threats to biodiversity and ecosystem services, especially focusing on habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution. It will also take into account the differing values attached to biodiversity and ecosystem services by Affected Communities and, where appropriate, other stakeholders. Where paragraphs 13–19 are applicable, the client should consider project-related impacts across the potentially affected landscape or seascape."*

8.2.5 National Legislation

The GAME has established ambient water quality standards. These standards introduce a baseline standard of water quality which aims to protect the Kingdom of Saudi Arabia's water supply and natural aquatic environment whilst allowing for sustainable economic and social development.

The ambient water quality standards for surface and groundwater in the Kingdom of Saudi Arabia are listed in Table 8-1.

Table 8-1: Ambient Water Quality Standards

Parameter	Unit	Surface Water	Groundwater
Temperature	ºC	ABD	n/a
pH	pH Units	ABD	ABD

Parameter	Unit	Surface Water	Groundwater
Salinity	%	ABD	ABD
TDS	mg/l	5,000	ABD
TSS	mg/l	5	ABD
Turbidity	NTU	30	ABD
Dissolved Oxygen	mg/l	>5	n/a
Biological Oxygen Demand	mg/l	10	n/a
Chemical Oxygen Demand	mg/l	25	n/a
Oil and Grease	mg/l	3	0
TKN	mg/l	3	ABD
TOC	mg/l	10	ABD
Phosphorus (total)	mg/l	0.5	0.3
Phosphorus (PO4-P)	mg/l	0.1	ABD
Ammonia (Free as NH3)	mg/l	0.1	0.3
Chloride (as Cl)	mg/l	ABD	ABD
Calcium (CaCO3)	mg/l	ABD	ABD
Inorganic Nitrogen (as Nitrite and Nitrate)	mg/l	1	30
Sodium	mg/l	150	150
Sulfate	mg/l	200	250 (Guide)
Sulfide	mg/l	0.002	0.002
Total Petroleum Hydrocarbon	mg/l	0.3	0.2
ABD – Above Background Levels			

8.3 Baseline Environmental Conditions

In addition to literature review, the hydrology and flood risk assessment of the developable area undertaken by AECOM (2017), and the geotechnical assessment of the developable area undertaken by Arab Company for Laboratories and Soils (2016) have been used to characterize the baseline hydrology and hydrogeology conditions of the Park.

8.3.1 Regional Groundwater

The groundwater resources within the Kingdom of Saudi Arabia are almost exclusively found within eight large tectonic basins of sedimentary rocks bordering the Arabian Shield (Vincent, 2008). The development site is located above two primary aquifers: the Saq Sandstone aquifer and the Wasio-Biyadh-Aruma aquifer (Figure 8-1 and Figure 8-2). The Tawil-Quaternary Aquifer is a further system associated with these primary aquifers (Figure 8-3).

8.3.1.1 Saq Sandstone Aquifer

The development site is located to the east of the exploitable resource area of the Saq Sandstone aquifer. Figure 8-1 shows the sub-surface extent of the Saq aquifer and the exploitable area. Groundwater is found in the Saq aquifer at depths of between 150 m in the outcrops in Wadi Sirhan, to over 400 m in central Jordan (UN, 2013).

The Saq aquifer is of early Ordovician age and forms the major aquifer in northern Saudi Arabia and it is reported as being of good quality (Vincent, 2008). Isotopic dating indicates that the water in the aquifer is 22,000 to 28,000 years old and there is very little present day recharge. In the Qasim region to the south the aquifer has been over exploited. The reserves in this aquifer are estimated ot be 290,000 x 10^6 m^3, although recharge rates are estimated to be 310 x 10^6 m^3 (Vincent, 2008).

Groundwater abstraction in the Tabuk area has increased dramatically from approximately 29 million cubic meters (MCM)/yr in 1983 to between 1,050-1,700 MCM/yr in 2004, mostly in the agricultural sector, while recharge remains at 3-10 MCM/yr. The heavy mining of the aquifer system has resulted in water level drops of up to 32 m/yr in the late 1980s in Saudi Arabia. There are indications that the exploitable part of the resource may be exhausted within 30-40 years, unless abstraction can be controlled on both sides of the border (UN, 2013).

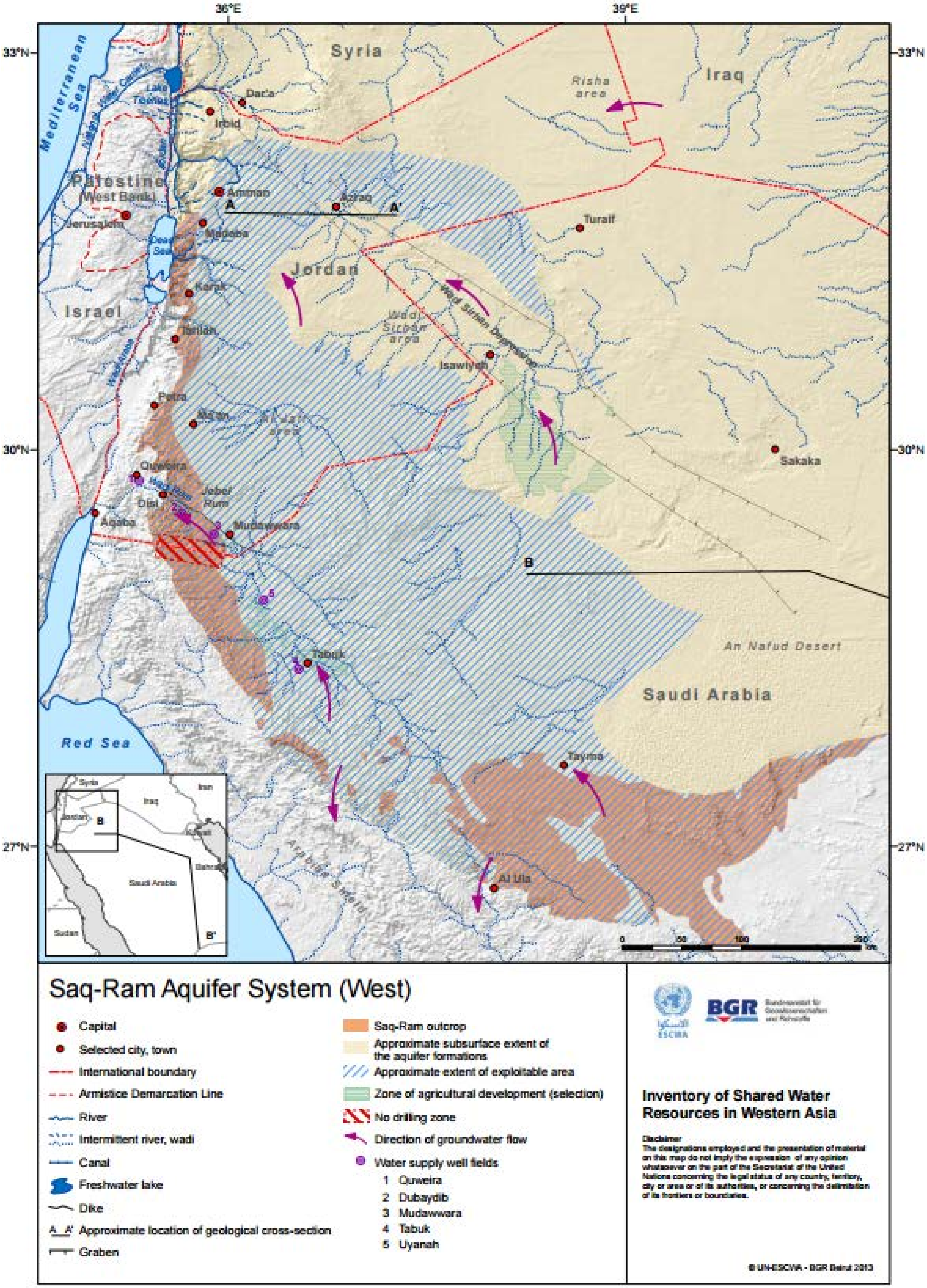
36°E
39°E
33°N
30°N
27°N
Mediterranean Sea
Syria
Iraq
Risha area
Lake Tiberias
Dar'a
Irbid
Palestine (West Bank)
Amman
Azraq
A
A'
Jerusalem
Turaif
Madaba
Dead Sea
Jordan
Karak
Israel
Wadi Sirhan area
Wadi Sirhan Depression
Tafilah
Isawiyah
Petra
Ma'an
Quweira
Jebel Rum
Disi
Aqaba
Mudawwara
Sakaka
B
An Nafud Desert
Tabuk
Saudi Arabia
Red Sea
Tayma
Al Ula
Syria
Iran
Iraq
Jordan
B
Saudi Arabia
Sudan
Bahrain
B'
0
50
100
200
km
Saq-Ram Aquifer System (West)
Capital
Selected city, town
International boundary
Armistice Demarcation Line
River
Intermittent river, wadi
Canal
Freshwater lake
Dike
A A' Approximate location of geological cross-section
Graben
Saq-Ram outcrop
Approximate subsurface extent of the aquifer formations
Approximate extent of exploitable area
Zone of agricultural development (selection)
No drilling zone
Direction of groundwater flow
Water supply well fields
1 Quweira
2 Dubaydib
3 Mudawwara
4 Tabuk
5 Uyanah
ESCWA
BGR
Inventory of Shared Water Resources in Western Asia
Disclaimer
The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.
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Figure 8-1: Saq Aquifer (ISWR 2013)

8.3.1.2 Wasia-Biyadh-Aruma Aquifer

The exploitable area of the Wasia-Biyadh-Aruma aquifer, also known as the Sakaka-Rutba aquifer, lies to the north and north-east of the development site. The Wasia-Biyadh-Aruma aquifer is of lower and middle cretaceous sandstones and is located in the Northern Interior Homocline and the Widyan Basin margin. The Wasia formation is the single most important lithostratigraphic unit for water resources in the Kingdom of Saudi Arabia (Vincent, 2008).

The reserves in this aquifer are estimated to be 590,000 x 10^6 m^3, although recharge rates are estimated to be 480 x 10^6 m^3 and the exploitation depth ranges between 200 and 400 m below ground level (UN, 2013). The use of this aquifer system is currently limited due to its remoteness and the harsh environment in the area but the towns of Ar'ar and Sakaka in Saudi Arabia presumably rely on the aquifer system for their water supply (UN, 2013). Figure 8-2 shows the Wasia-Biyadh Aruma Aquifer.

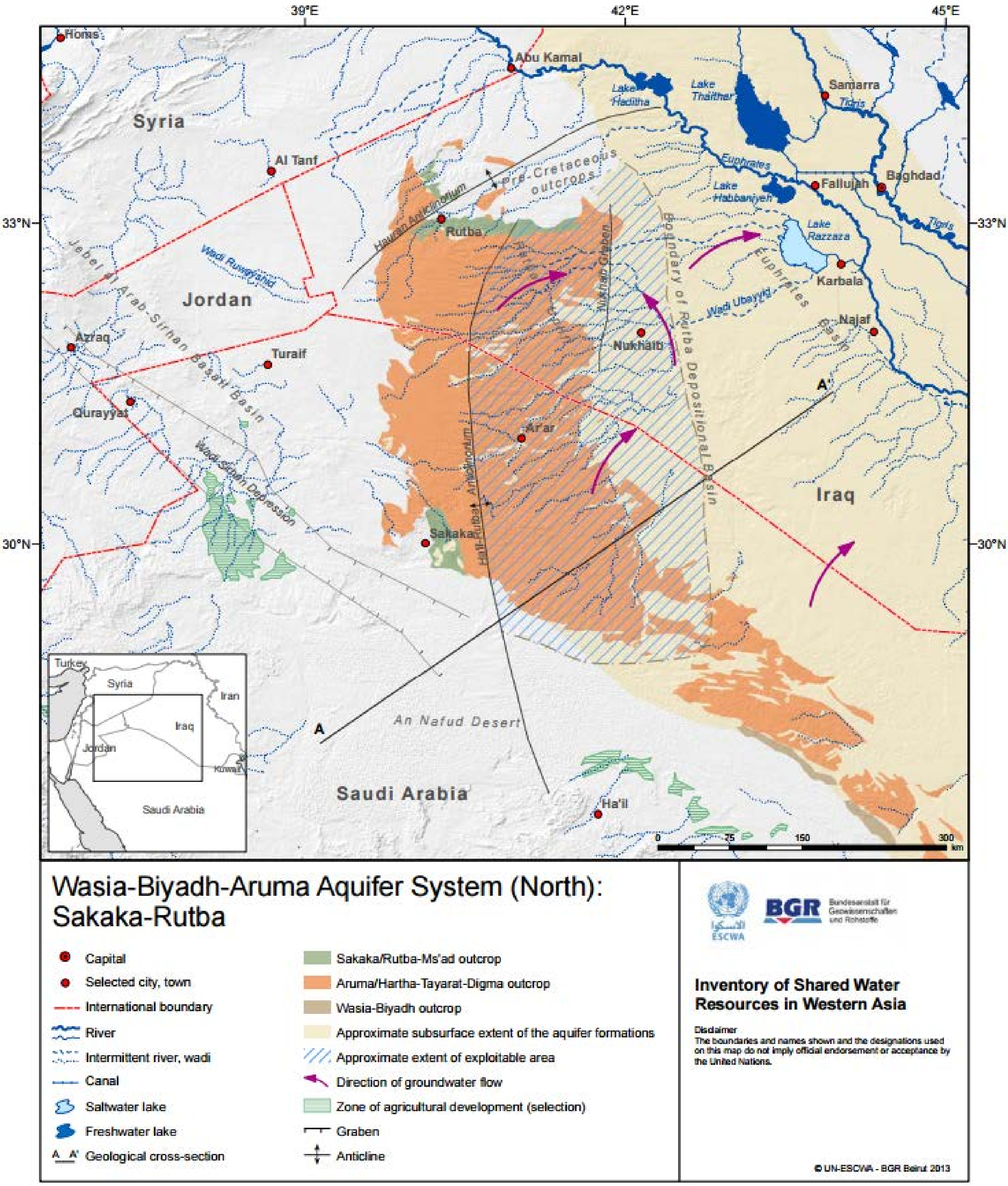

Figure 8-2: Wasia-Biyadh-Aruma Aquifer System (North): Sakaka-Rutba

8.3.1.3 Tawil-Quaternary Aquifer: Wadi Sirhan Basin

The Tawil-Quaternary Aquifer System, also referred to as the Wadi Sirhan Basin, extends from the eastern boundaries of the Basalt Aquifer towards the Sakaka - Al Jouf area. The Wadi Sirhan Basin is comprised of sedimentary water-bearing formations in a zone of subsidence shaped by subsurface faults associated with major crustal movements (UN, 2013). These water-bearing formations were subjected to deep and significant fracturing with large vertical displacement (50-1,500 m) and this tectonic setting resulted in the deposition of thick sediments since the late Cretaceous time, which dip towards the center of the depression (UN, 2013).

Before heavy abstraction from the aquifer system started in the 1990s, depth to water was reported at less than 10 m below ground level. Today, exploitable reserves are located at a water level as far as 250 m below ground level. The present day recharge of the aquifer is limited. (UN, 2013)

The formations of the Tawil-Quaternary Aquifer System are comprised of an upper part (Upper Cretaceous to Quaternary) and a lower part (mainly Silurian- Early Devonian). There has been significant abstraction from this aquifer and subsequent depletion of resource. The exploitable reserves in this formation are estimated to be about 22 BCM (UN, 2013). Natural recharge to this aquifer is assessed as negligible and this aquifer has limited renewability. Figure 8-3 shows the Tawil-Quaternary Aquifer System.

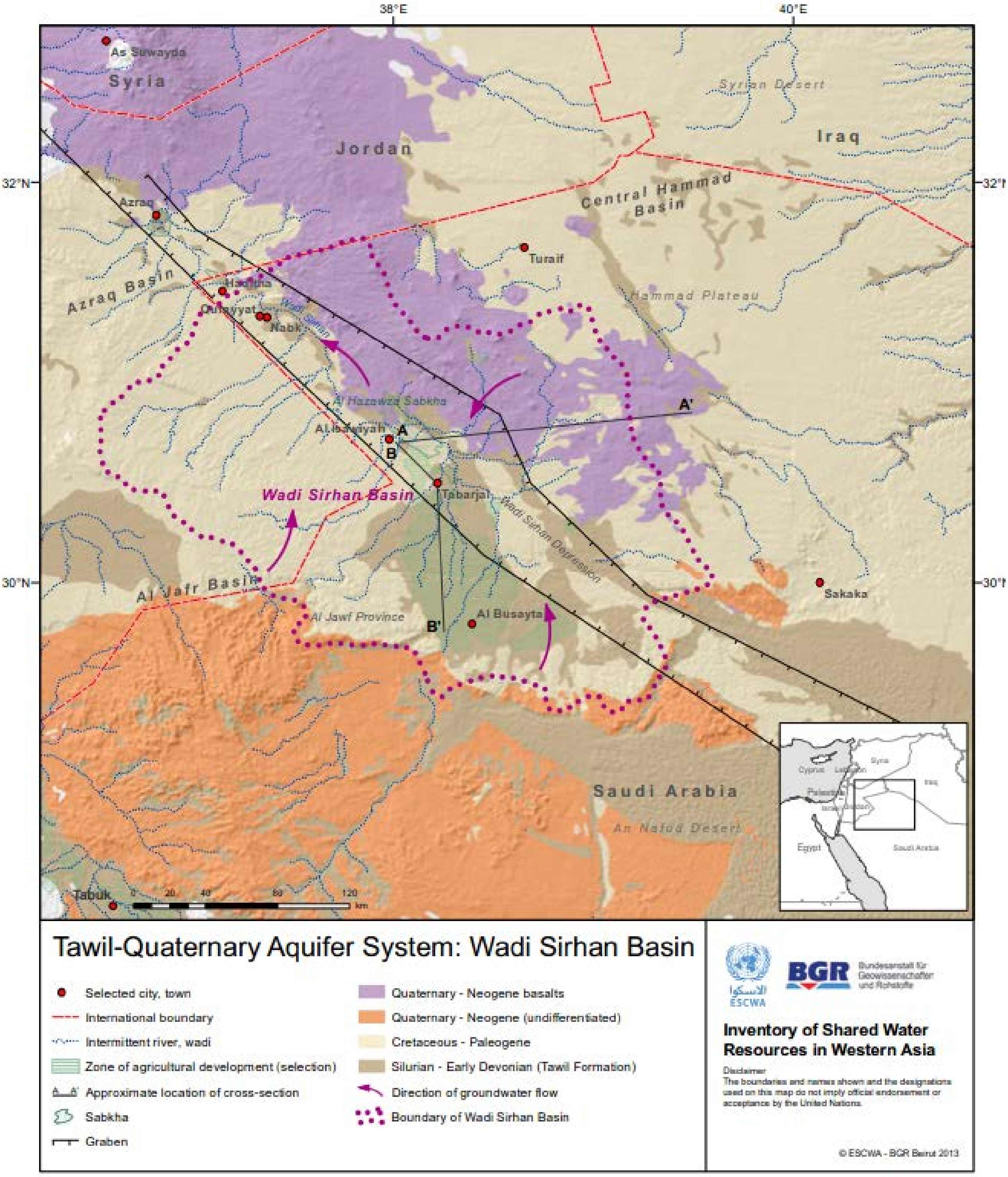

Figure 8-3: Tawil-Quaternary Aquifer System: Sakaka-Rutba

8.3.2 Local Groundwater

Saudi Aramco commissioned a geotechnical survey for the Park in 2016, undertaken by Arab Company for Laboratories and Soil (ACES, 2017). A total of ten boreholes were drilled between the 5th December 2016 and 10th January 2017. The boreholes were drilled up to 30 m depth or 10 m within intact rock (whichever was less below the existing ground level). Figure 8-4 shows the borehole locations.

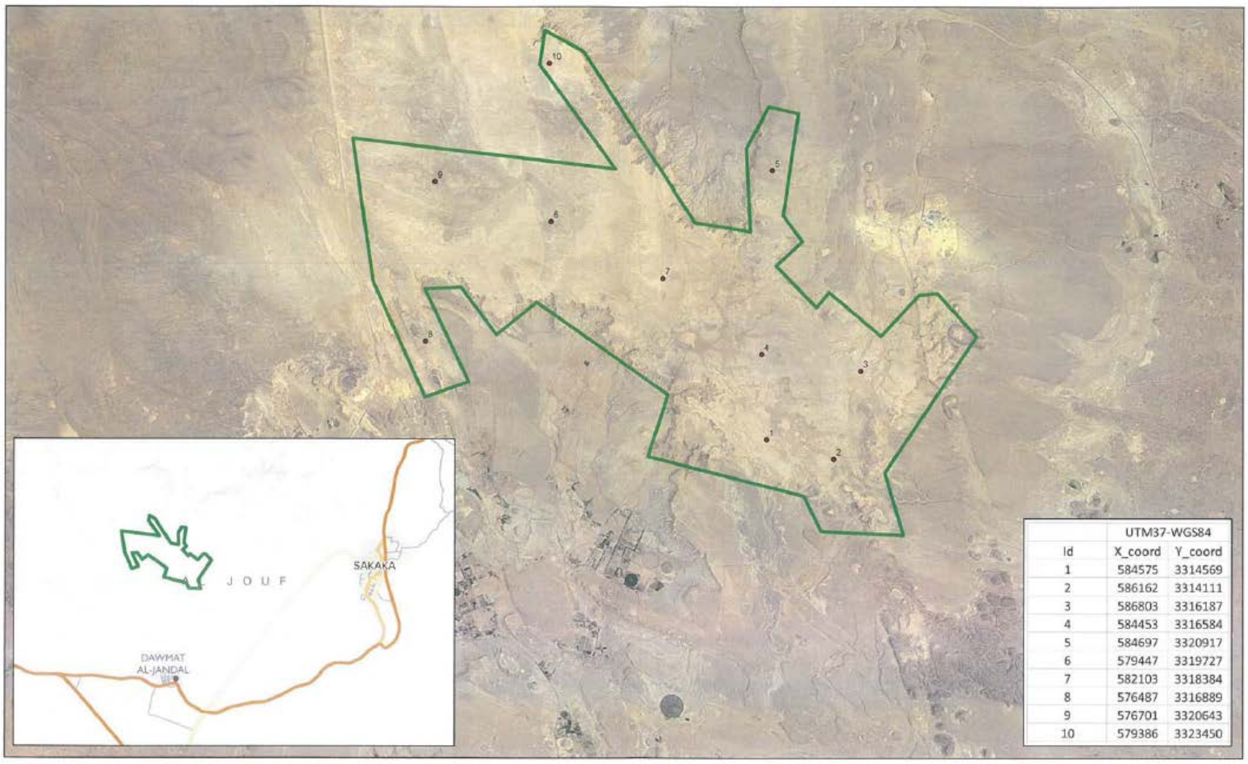

Figure 8-4: Borehole Locations

The geologic profiles of the boreholes and surface and subsurface ground materials in the study area can be divided into the following types: residual soil, limestone, sandy marlstone, chalky limestone, quartzite and marly limestone. The surface and subsurface ground materials for the boreholes are summarized in Table 8-2. Groundwater was not encountered in any of the boreholes.

Table 8-2: Soil and Rock Formation with approximate boundaries

Borehole	Residual Soil	Limestone	Sandy Marlstone	Chalky Limestone	Quartzite	Marly Limestone
	Depth Range in Meter below existing ground level					
BH-01	0.0 – 0.4	0.04 – 7.5	7.5 - 15	-	-	-
BH-02	-	-	1.5 – 16.5	0.0 – 0.15	-	-
BH-03	-	0.0 – 6.0	6.0 – 15.0	-	-	-
BH-04	-	-	6.0 – 16.5	0.0 – 6.0	-	-
BH-05	-	0.0 – 9.0	9.0 – 12.0	-	-	-

Borehole	Residual Soil	Limestone	Sandy Marlstone	Chalky Limestone	Quartzite	Marly Limestone
	Depth Range in Meter below existing ground level					
BH-06	-	1.5 – 12.0	-	-	-	0.0 – 1.5
BH-07	-	-	9.0 – 13.5	0.0 – 9.0	-	-
BH-08	-	0.0 – 13.5	-	-	-	-
BH-09	-	-	12.0 – 13.0	4.5 – 12.0	0.0 – 4.5	-
BH-10	0.0 – 0.4	0.4 – 4.5	4.5 – 15.0	-	-	-

A study commissioned by the then Ministry of Water and Electricity inventoried the groundwater abstraction boreholes within the exploitable area of the Saq Sandstone Aquifer. As part of the study, a total of 5,969 water points were inventoried, which included wells for domestic water supply, and agricultural irrigation. As can be seen in Figure 8-5, there is a concentration of boreholes in the vicinity of Sakaka and Dumat al Jandal which support agricultural irrigation. In total, 4,972 of the wells are for irrigation, whilst 573 are for domestic water supplies.

Data presented in the report “Groundwater Management in Saudi Arabia” (FAO, 2009) indicates a gradual decline in major aquifer water levels in the Kingdom of Saudi Arabia since the start of the data in 1980. A declining trend in aquifer water levels in the development area may also be expected (FAO, 2009).

Agriculture is a primary source of economic activity within Al Jouf province and groundwater abstraction supplies the majority of irrigation demand. Historic and ongoing abstraction from aquifers in this region is contributing towards the depletion of this natural resource with limited renewability. These resources are precious as they are not the product of an ongoing hydrological cycle (FAO, 2009).

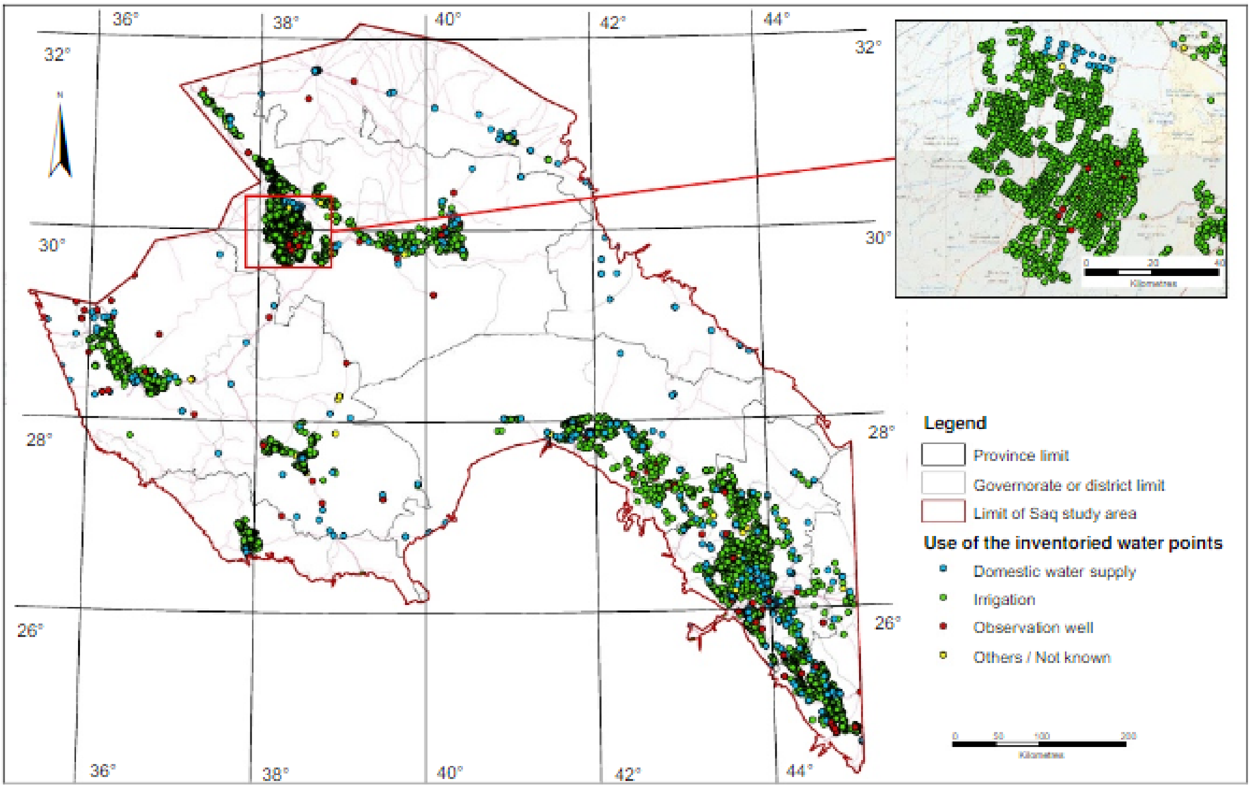

Figure 8-5: Location Map of the Inventoried Water Points of Saq Aquifer (source: MOWE, 2008)

A cross section of the aquifers in the region has been developed by the Ministry of Water and Electricity (2008) and is illustrated in Figure 8-6.

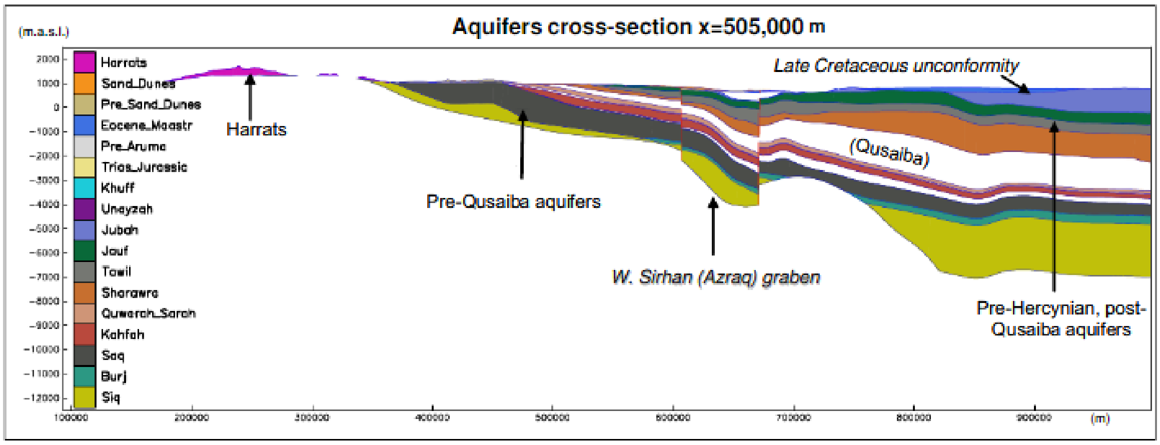

Figure 8-6: North-south Cross-chapter along the 40°E Meridian (longitude of Sakaka) (Source: MOWE, 2008)

8.3.3 Regional Surface Water

As reported by AECOM (2017), the wider regional ASTER[5] analysis shows the main flow paths and catchments surrounding the site (Figure 8-7). As wadi names are not readily available, the main wadi catchments were labelled A to E for ease of reference by AECOM (2017). Whilst the flow paths are not particularly well defined in the aerial imagery, there are relatively clear drainage divides between these wadi systems. Major catchments B and C drain away to the east, the former terminating in the depression in the area between Sakaka and Dumat Al Jandal. Major catchments D and E drain away to the west. Catchment A contains flow paths which drain towards Dumat Al Jandal.

The location of the development site is illustrated on Figure 8-7. The Park is located within Catchment B.

[5] Advanced Spaceborne Thermal Emission and Reflection Radiometer – a data set of geographical terrain data surveyed from space.

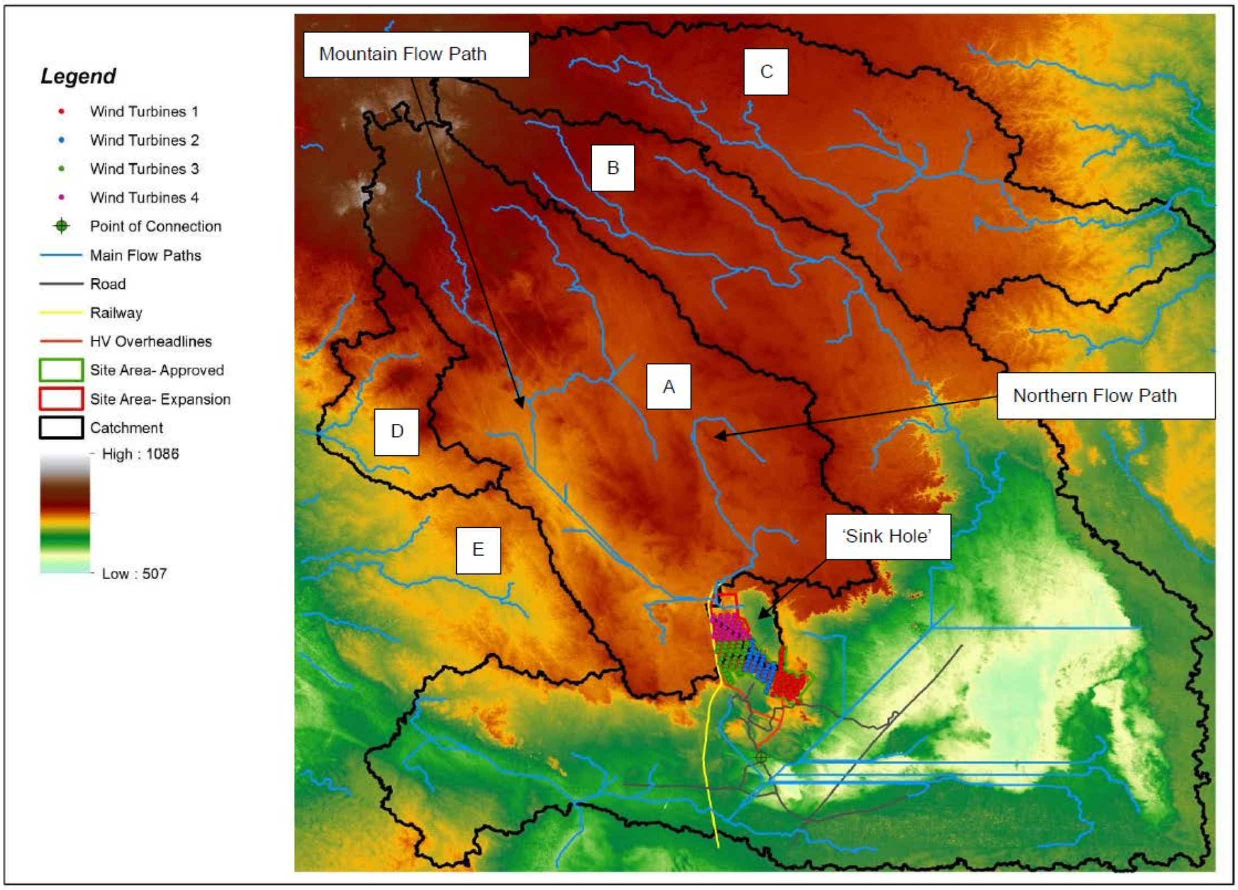

Figure 8-7: Flow Paths (source: AECOM (2017)

There are two permanent water bodies within the local region (Figure 8-8). There is a lake approximately 13 km to the south of the Park, which is one of the few remaining wetland habitats in the northern desert of the Kingdom of Saudi Arabia. Until 1983-1984 it was a medium-sized natural lake surrounded by a large marsh of reeds and sedges (900 ha overall), but this has now been drained and converted to agricultural smallholdings; the water is pumped to an elevated basin in the hills overlooking the former marsh, forming a reservoir (150 ha). From here water flows through a number of irrigation channels back to the agricultural areas, where there are some very small, scattered remnants of marshland.

The reservoir is used for recreation in summer, and Tilapia fish have been introduced (Birdlife International, 2016). The site has been designated as an Important Bird and Biodiversity Area (IBA) by Birdlife International.

There is also a second lake located to the south-east of the town of Sakaka, approximately 35 km to the east of the Park. The lake is fed by treated waste water and unlike Dumat al Jandal, it is a man-made feature. The lake is surrounded by dunes and a dense fringe of reeds *Phragmites* spp.

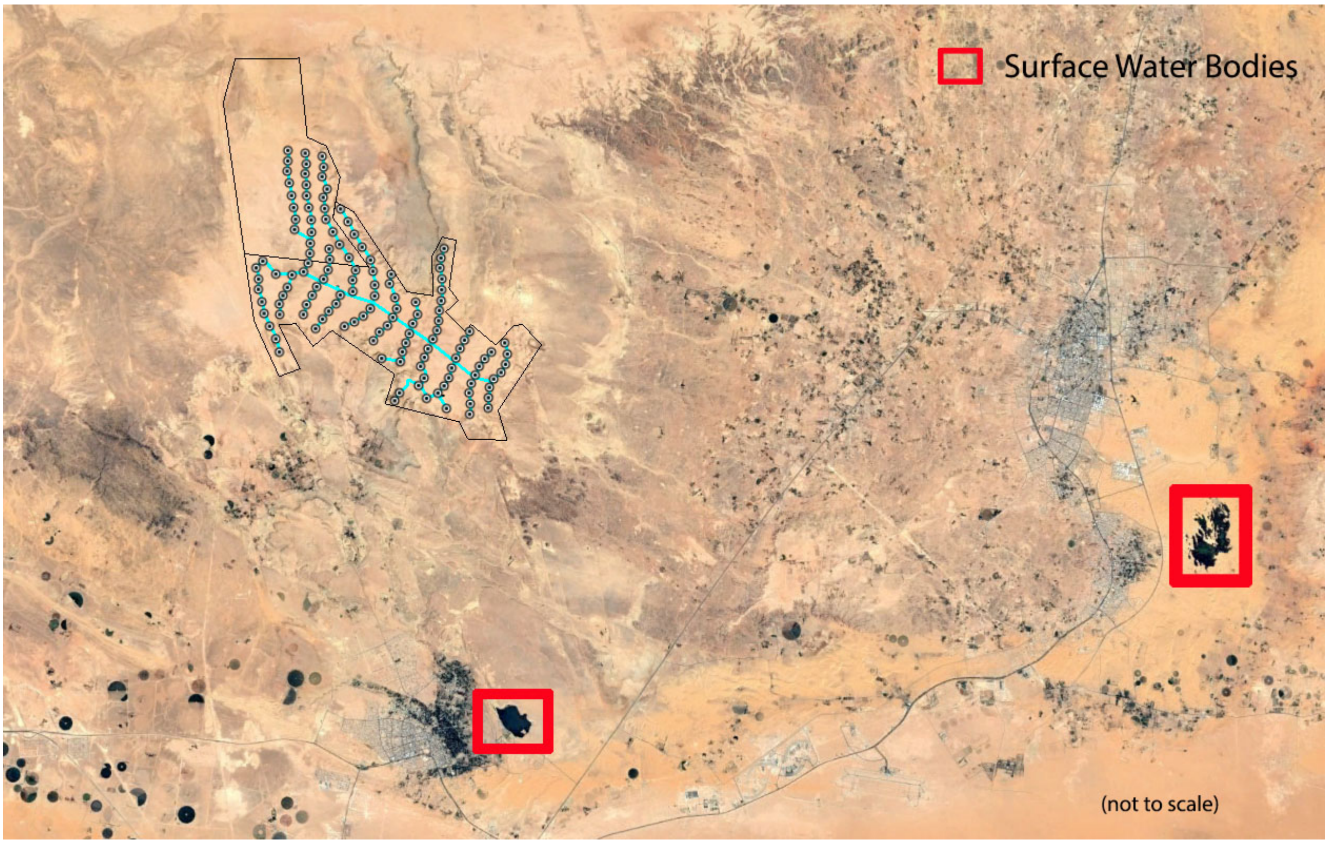

Figure 8-8: Surface Water Bodies

8.3.4 Local Surface Water

There are no permanent surface water features within or adjacent to the Park. Detailed digital terrain data supplied by Saudi Aramco, with a vertical accuracy of <+/- 0.5 m, has been used to develop a preliminary understanding of the catchments and seasonal flow paths within and adjacent to the Park (Figure 8-9).

Within the available high resolution terrain data, the Phase 1 analysis completed by AECOM (2017) identifies several watershed catchments within the site itself; these catchments all drain away from the high level plateau to the lower surrounding land (Figure 8-9). AECOM has concluded that based on this analysis alone, there does not appear to be any significant flow path entering the developable area of the Park from the wider area, indicating minimal risk from these sources. However, due the number of potential flow paths within the site, there is a potential risk of pluvial flooding and erosion, and this is considered further in Section 8.5. The largest of the catchments which drains to the south of the Park, suggests that there might be conflicts with the local road network.

The northern part of the developable area drains to the west, and the high resolution terrain data indicates a connection with the ‘mountain flow path’ (Figure 8-7). Similarly, the ‘northern flow path’ (Figure 8-7) does not appear to flow west but would preferentially flow east terminating in the ‘sink hole’ to the east of the Park.

There is no evidence that local communities derive direct benefit from the surface water run-off from the developable area of the Park (i.e. water supplies, groundwater recharge, irrigation), and flows do not contribute to any existing surface water features in the wider landscape.

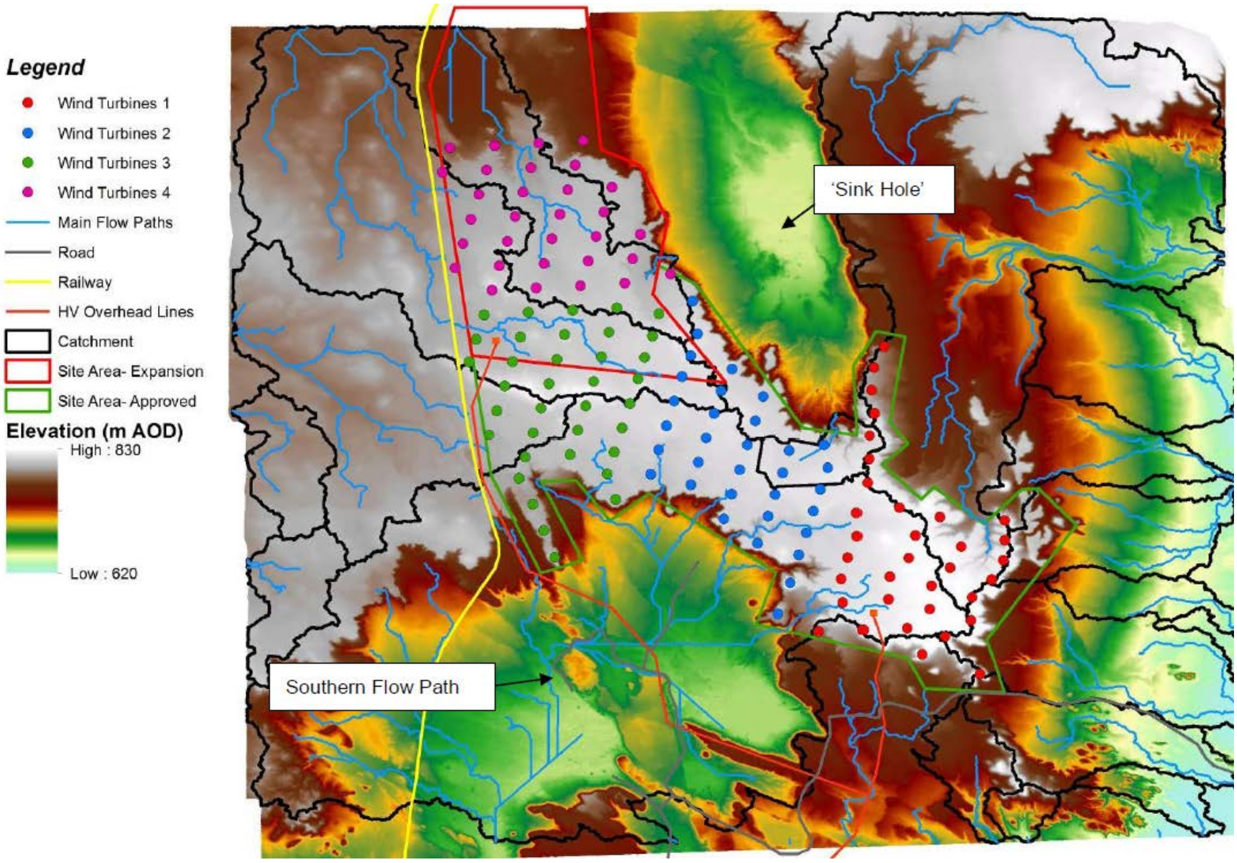

Figure 8-9: Main flow paths within and adjacent to Dumat Al Jandal Wind Energy Park (source: AECOM (2017))

8.3.5 Annual Rainfall

8.3.5.1 Rainfall Data

In order to predict the hydrological regimes and flood risk at the development site, future rainfall was simulated using available data from the nearest rainfall monitoring stations to the development site. Seventeen rainfall gauges with available data were utilized; the locations of these gauges are shown in Figure 8-10.

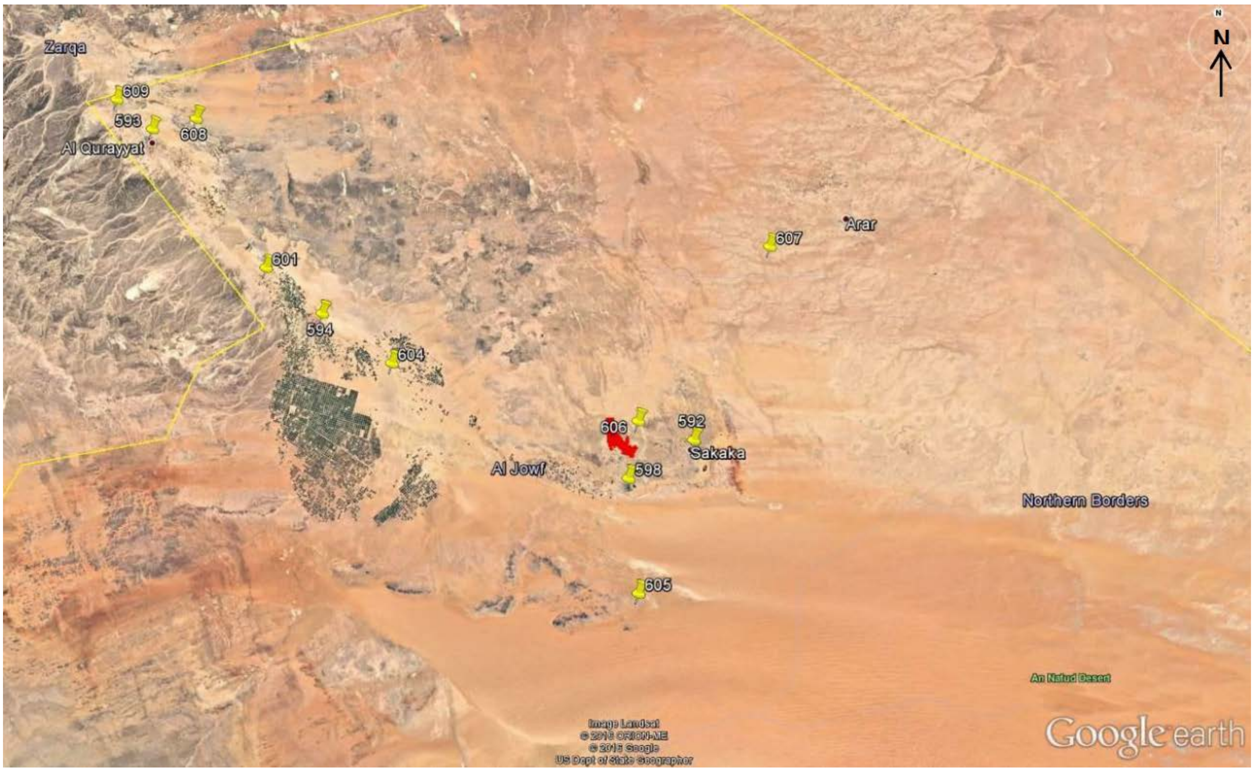

Figure 8-10: Rainfall Gauges with Available Data (source: AECOM (2017))

The data available at each of these stations was inconsistent, with some stations showing as much as 33 years of missing data. Table 8-3 shows the periods of data available at each monitoring station and the consistency of that data.

The coordinates for gauge 962, based on rainfall data files provided by Saudi Aramco Environmental Protection Department indicated that this gauge was located in the Isparta province of Eastern Turkey. It was considered that there may have been an error made during preparation of the data files, and that the latitude and longitude values have been reversed. The result of reversing these coordinates places the gauge at the same location as gauge 601. However, the data records at these two gauges are not comparable. This cast uncertainty on the use of gauge 962 in the subsequent analysis.

Table 8-3: Rainfall Data

Gauge No.	Gauge Name	Data	Start Date	End Date	No. of Years With Data	No. of Years of Missing Data
592	Sakaka	Daily	1964	2013	41	9
593	Unknown	Daily	1971	2013	19	25
594	Unknown	Daily	1969	2013	21	24
598	Jandal	Daily	1965	2013	49	0
601	Issawiya	Daily	1964	2013	40	10
603	Unknown	Daily	1966	2013	23	25

Gauge No.	Gauge Name	Data	Start Date	End Date	No. of Years With Data	No. of Years of Missing Data
604	Nabek Abouksr	Daily	1965	2013	45	4
605	Unknown	Daily	1965	2013	27	22
606	Marri	Daily	1972	2013	21	21
607	Ammaria	Daily	1983	2013	26	5
608	Manat	Daily	1969	2013	12	33
609	Unknown	Daily	1983	2013	29	2
952	Unknown	Daily	1964	2013	18	32
962	Alhoaahtah	Daily	1965	2002	27	11
1029	Unknown	Daily	2000	2013	5	9
1030	Unknown	Daily	2010	2013	3	1
1071	Unknown	Daily	2010	2013	2	2

8.3.5.2 Rainfall Frequency Analysis

The data provided was used to predict the frequency and severity of rainfall events within the 100 year return period. This is representative of events which have a 1 % probability of occurring in any one year, and this return period has been selected for flood risk modelling. The '100 year Rainfall Depth' column in Table 8-4 shows the depth of rainfall with a 1% probability of occurring in any one year at each of the three monitoring locations closest to the development site.

Table 8-4: Estimated 1 in 100 Year Rainfall Depths Based on Single-site Analyzes

Gauge No.	Gauge Name	No. of Years Record	Gauge Elevation (m AD)	Median Annual Maximum Value (mm)	100yr Rainfall Depth (mm)
592	Sakaka	41	574	13.0	60.3
598	Jandal	49	650	13.4	52.4
606	Marri	21	620	9.4	35.9

8.3.5.3 Pooled Analysis

Due to the fragmented nature of the data available and the inconsistencies within it, combined with the potential failure and extended non-operational status of gauges during extreme events, and historical extreme rainfall not covered by the recording period of many of the gauges, the data is unlikely to be fully representative of the complete range of extreme rainfall events which occur in the region.

Pooling is considered to provide the most robust method making use of all the available data. Pooling provides a means of grouping data from several gauges across a region together and creating a robust data set from them.

The pooling approach is usually preferable to single-site analyses given that it takes account of a much larger data-set than any of the individual single-site analyses. Gauges 1030 and 1071 were excluded from analysis due to the short periods of available data recorded at those locations. Due to the discrepancy regarding its actual location, gauge 962 was also excluded from this analysis. Cumulatively, there are 376 station years of data between the nine gauges; therefore there can be greater confidence in the estimates of the 1 in 100 year rainfall depth than would be the case with single site analysis.

Two pooling groups were developed to assess the potential variability in the resultant growth curve:

1. Pooling Group 1 (PG1) comprised data from fourteen gauges (gauges 962, 1030 and 1071 excluded) –376 years of data; and;

2. Pooling Group 2 (PG2) only comprised data from the three gauges closest to the study area: 592, 598 and 606 – 111 years of data.

Table 8-5 shows the results of the pooled analysis and the rainfall depths for each return period.

Table 8-5: Design Rainfall Estimates

Pooling Group/Guage	Return Period Design Rainfall Depths (mm)							
	2yr	5yr	10yr	25yr	50yr	75yr	100yr	200yr
PG1	11.9	20.8	27.8	38.1	46.9	52.6	57.0	68.3
PG2	11.9	19.9	25.8	34.3	41.4	45.9	49.2	57.7
592	13	22.0	29.2	40.0	49.4	55.6	60.3	72.7
598	13.4	21.9	28.3	37.2	44.5	49.0	52.4	60.9
606	9.4	15.9	20.5	26.5	31.1	33.9	35.9	40.8

Pooling rainfall data from the gauges closest to the windfarm site (PG2) would be the preferable approach; however, the pooled record length is only 111 years, which is considered insufficient to be representative of the potential variability in rainfall depths.

PG1 is considered to provide the best estimate of the 1 in 100 year design rainfall depth for the Dumat Al Jandal windfarm site. The 1 in 100 year daily design rainfall depth estimate is therefore 57 mm.

The report noted the following: *'Estimating design rainfall is associated with a high degree of uncertainty. This is the case for data-rich countries such as the UK and is magnified in data-poor countries such as Saudi Arabia. The limited number of rain gauges available for analysis, their short, fragmented records, the limited number of extreme events recorded and no sub-daily data being available, all serve to heighten the uncertainty associated with the analysis.'*

8.4 Assessment Methodology

8.4.1 Aquifer Vulnerability

Groundwater was not encountered at the development site and has not been considered further in the assessment of impact.

8.4.2 Prediction of Flood Risk

The data gathered during the baseline environmental assessment, was used to model the likely frequency and duration of storm events within the development site and its surrounding area. The modelling was carried out in order to understand the likelihood and severity of flood events, and subsequently, the impact that those events may have upon the Dumat al Jandal Wind Energy Park.

The area, in which the site is located, is subject to two possible types of flooding: Pluvial and Fluvial.

- Pluvial flooding is surface water flooding; this is a result of direct rainfall. Generally this would occur during a storm event, without much lead in time. Within a Wadi valley this would comprise the water that flows down the hillsides of the valley towards the site, and flooding would usually occur during or relatively soon after a large rainfall event. For surface water (pluvial) flooding the source of the flooding is rainfall, and the pathway is across land, down slopes and in some watercourses.
- Fluvial flooding is wadi flooding, which is a result of rainfall further up in the catchment of the river. If a site is within the valley of a wadi, a storm further up in the catchment which takes time to reach the site could cause a flood. The source of the flooding would be rainfall within the catchment, and the pathway would be the wadi, which can then flood the site once the flow in the wadi exceeds the capacity of the channel.

AECOM has concluded that based on an analysis of the digital terrain data alone, there does not appear to be any significant flow path entering the developable area of the Park from the wider area, indicating minimal risk of fluvial flooding. However, due to the number of potential flow paths within the site, there is a potential risk of pluvial flooding and erosion.

8.4.2.1 Catchment and Flow Path Analysis

As reported in Section 8.3.4, the Phase 1 analysis completed by AECOM (2017) identifies several watershed catchments within the site itself; these catchments all drain away from the high level plateau to the lower surrounding land (Figure 8-9). AECOM has concluded that based on this analysis alone, there does not appear to be any significant flow path entering the developable area of the Park from the wider area, indicating minimal risk from these sources. However, due to the number of potential flow paths within the site, there is a potential risk of pluvial flooding and erosion, and this is considered further in Section 8.5. The largest of the catchments which drains to the south of the Park, suggests that there might be conflicts with the local road network.

The northern part of the developable area drains to the west, and the high resolution terrain data indicates a connection with the ‘mountain flow path’ (Figure 8-7). Similarly, the ‘northern flow path’ (Figure 8-9) does not appear to flow west but would preferentially flow east terminating in the ‘sink hole’ to the east of the Park.

The flow paths identified and analyzed were not expected to impact upon surface water bodies in the vicinity of the development site, particularly Lake Dumat and the man-made lake to the south east of Sakaka. It is also important to note that these surface water bodies are primarily used for recreation, and do not provide water for domestic purposes.

8.4.2.2 Hydraulic Modelling

2D hydraulic modelling was undertaken by AECOM. This is a more realistic and accurate way of determining the natural flow paths than GIS based derivation methods. As reported by AECOM, this is because the software uses hydrodynamic equations to dynamically calculate the depth, velocity and direction of flow in each model element (triangle). Therefore the flow paths can bifurcate and merge, or cross theoretical sub-catchment boundaries as flow depth increases, as they would in reality.

2D modelling was run for 6 hour and 3 hour duration events for the 1 in 100 year return period. The flow depths and velocities for the 6 hour and 3 hour duration events are illustrated on Figure 8.11 to Figure 8.14. The modelling outputs indicate that flows would accumulate in a depression within the northern part of the developable area, but to the north of the proposed wind turbine locations. This demonstrates with a high degree of certainty, that the majority of the site would not be at risk from regional flow paths from the north or north-west. It also indicates that the future siting of any infrastructure in the northern part of the site expansion area should be avoided without further analysis of flood risk and provision of suitable mitigation measures.

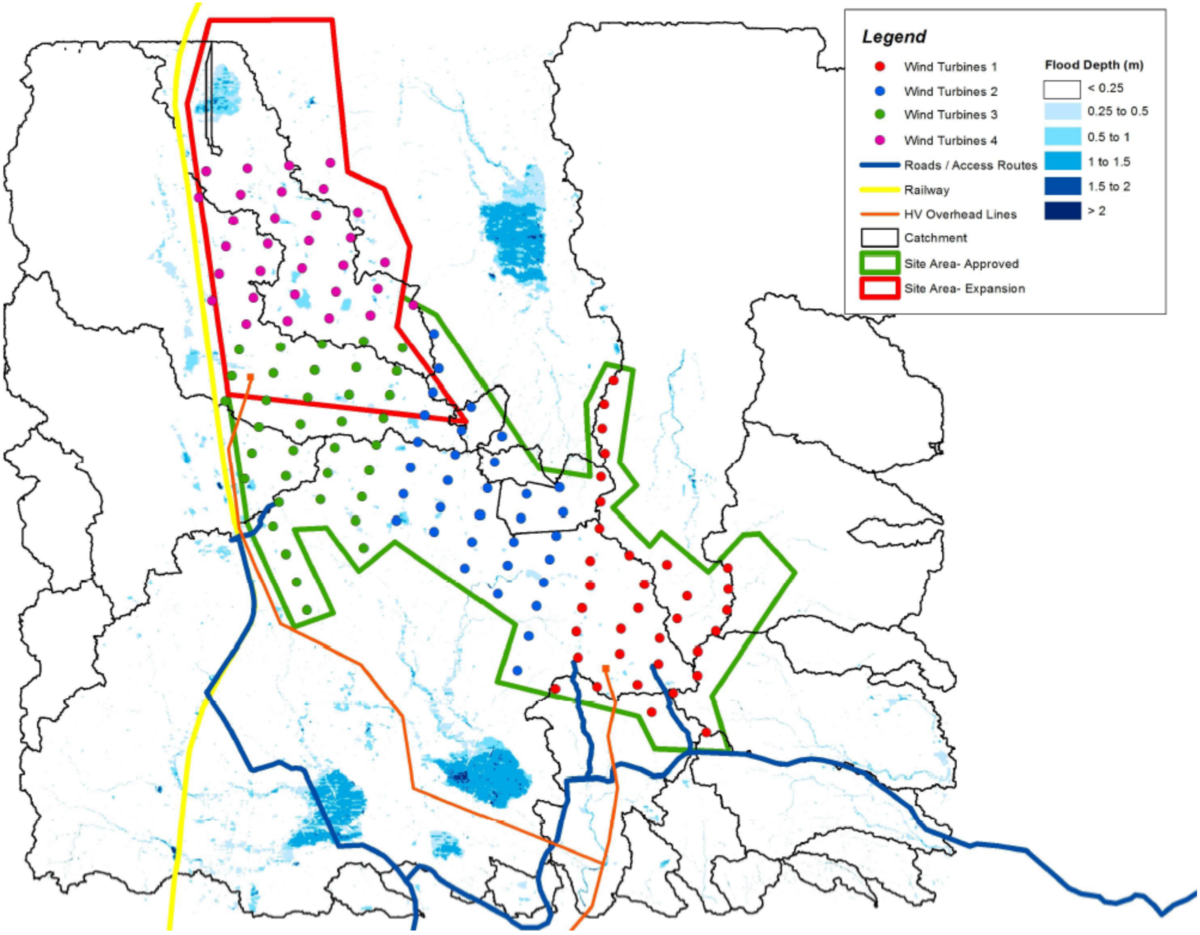

Figure 8.11: 1 in 100 Year flow depth across the study area (6 hour duration event)(source: AECOM (2017))

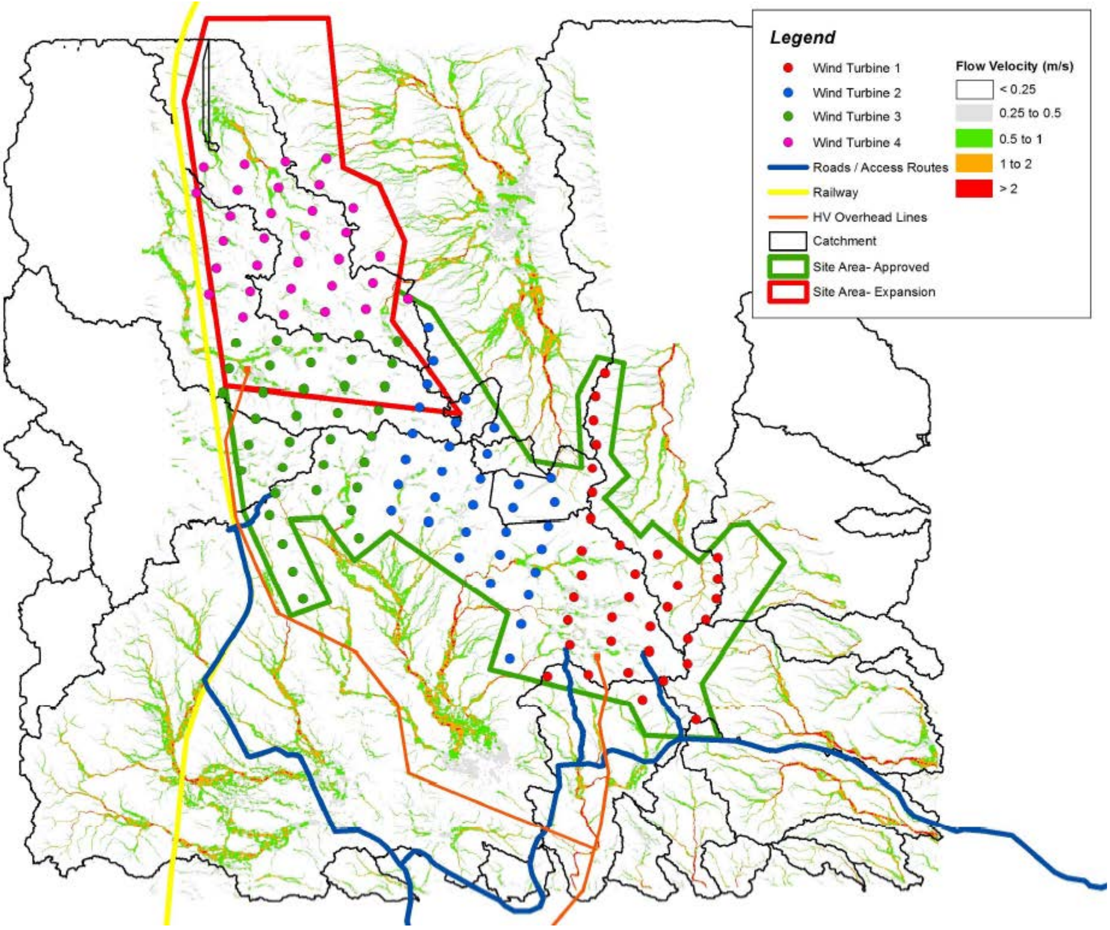

Figure 8.12: 1 in 100 Year flow velocity across the study area (6 hour duration event)(source: AECOM (2017))

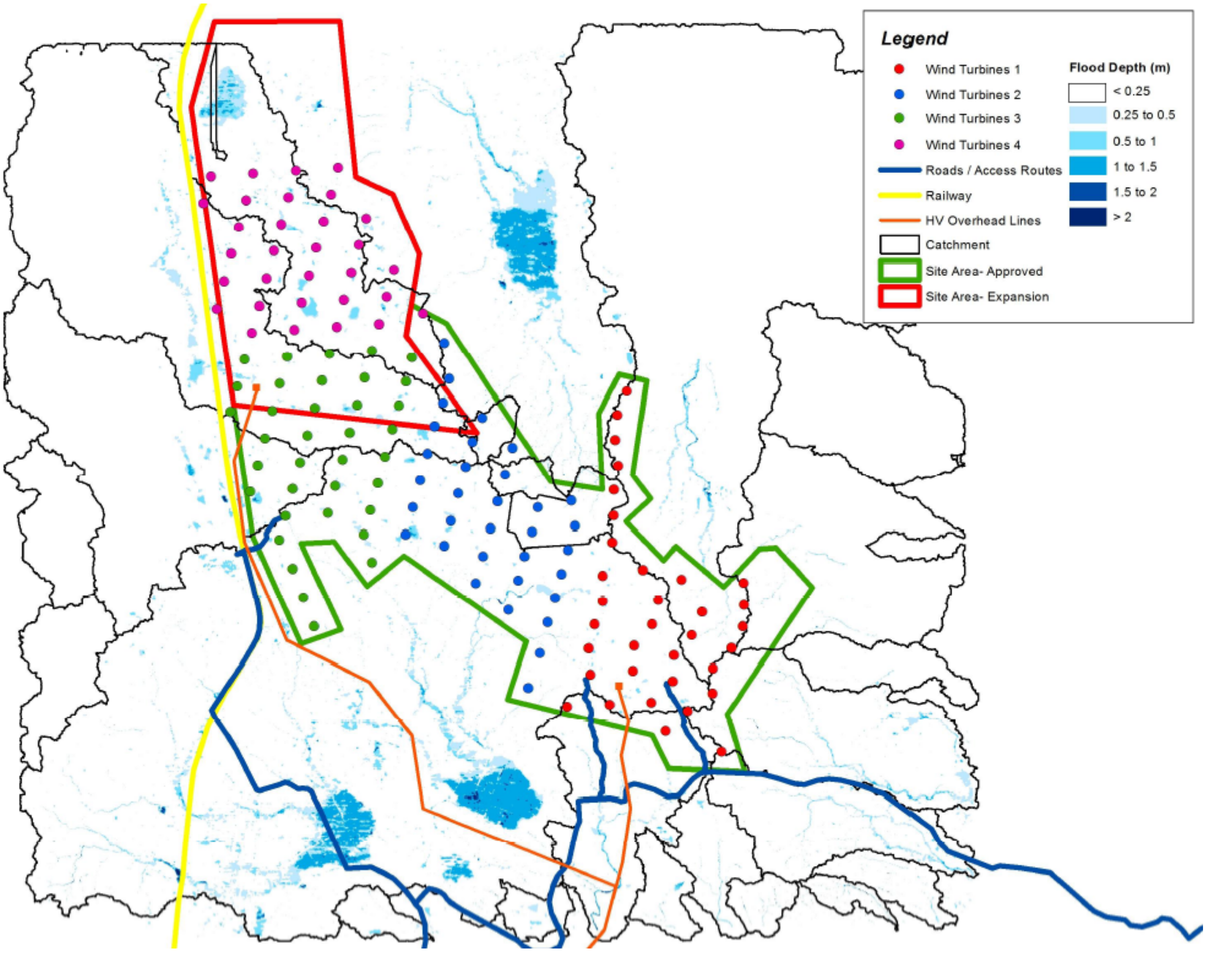

Figure 8.13: 1 in 100 Year flow depth across the study area (3 hour duration event)(source: AECOM (2017))

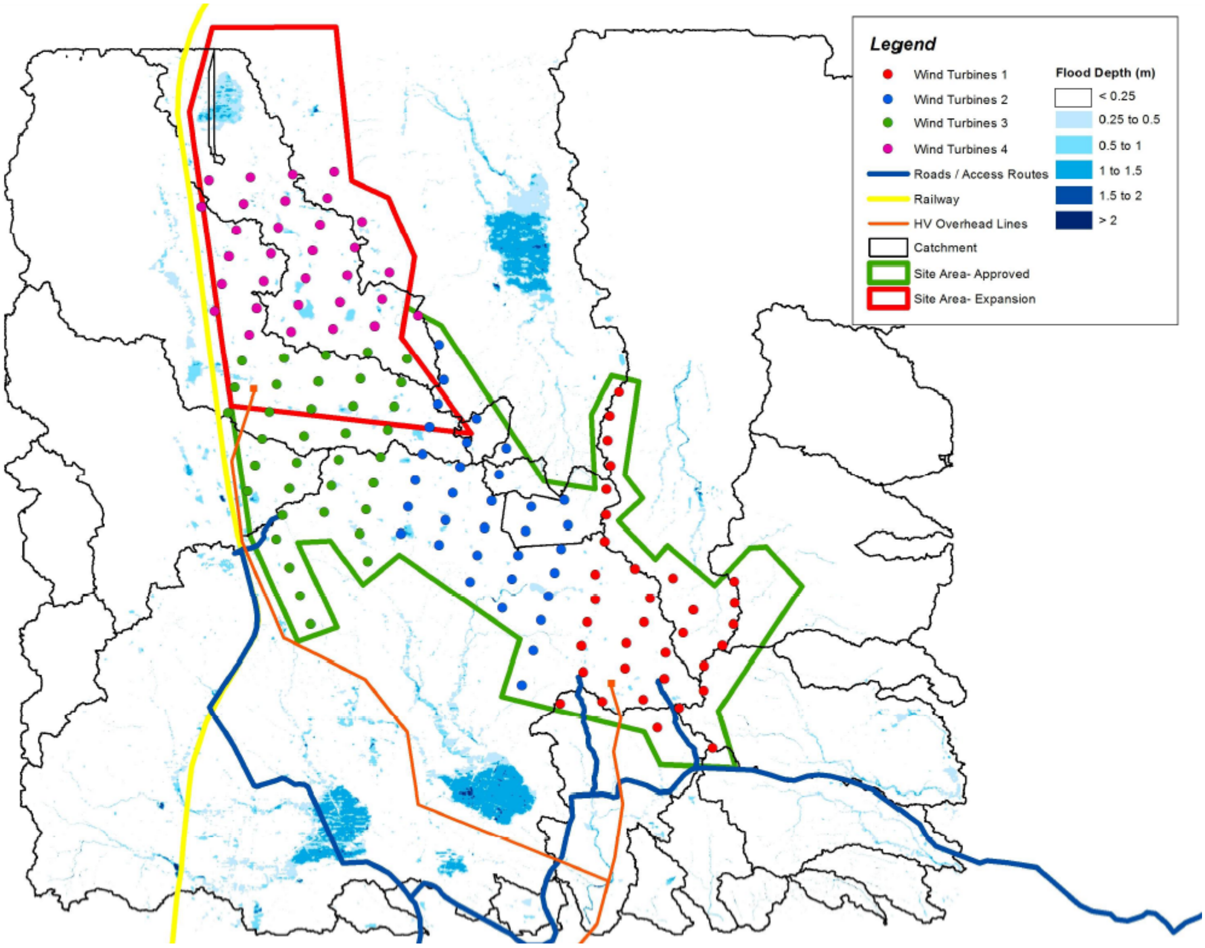

Figure 8.14: 1 in 100 Year flow velocity across the study area (3 hour duration event)(source: AECOM (2017))

8.4.2.3 Flood Risk Analysis

Turbines

The flood risk assessment identified that the majority of proposed wind turbine locations fall into the 'very low' risk category, with six turbine locations falling into the 'low' risk category. These turbine locations typically have a peak 1 in 100 year flow velocity of 0.5 to 1.0 m/s (AECOM, 2017).

There remains a residual flood risk for a small number of turbine locations, and it is recommended that these turbines are relocated outside of the defined flow paths, in accordance with the mitigation hierarchy.

AECOM has also completed a review of provisional turbine locations which could be affected through longer term erosion of adjacent topography. This review focused on sites in relative close proximity (nominally less than 100 m) to the edges of the plateau area, where defined flow paths have been identified. In line with the mitigation hierarchy, it is recommended that these turbines are relocated away from the edge of the plateau.

Where relocation of turbines is not feasible, AECOM has developed outline engineering mitigation proposals (AECOM, 2017). For all turbines considered to be at risk of flooding it is recommended that a site specific assessment of the turbine foundations' susceptibility to scour is undertaken.

Primary and Secondary Access Routes

The modelling results have been reviewed to identify potential risks to primary and secondary access routes which will service the wind farm. No formal details of access routes have been provided to facilitate the assessment. Therefore, the Primary access routes are assumed to be formed by the existing road network; and Secondary access routes are those within the developable area of the Park and which connect the individual turbine groups (AECOM, 2017).

Risks to access routes may occur during extreme flood event through scour. This can impact upon the condition of the access track in various ways including:

- Surface erosion and weakening of track material. Flows over the access track have the potential to loosen and remove the surface material creating localized low spots in the track within which water can pond and weaken its structure. The impact of this can vary from the creation of an uneven surface to the access track, rendering it impassable to some vehicles to full loss of the access track. Maintenance works would be required to reinstate the access track before it could be reused.
- Undermining the edges of access track. Turbulent flows over the access track have the potential to loosen and remove the softer and easily erodible material on either side of the access track creating scour holes. As these scour holes deepen, the access track can be undermined, resulting in the track material crumbling and slipping into the scour hole. The impact of this can vary from loss of track width to complete loss of the access track, rendering it impassable. Maintenance works would be required to reinstate the access track before it could be reused. The potential for this to occur is reduced by setting the access track flush with the adjacent ground, although the risk is not wholly removed.

The degree of scour which occurs to the access tracks is a function of the depth and duration of flow and the peak velocity of the flow over the access tracks. As flow depths and durations are relatively similar across the site, the risk to the access tracks is defined as:

- Very low risk (less than 0.5 m/s).
- Low risk (0.5 – 1 m/s).
- Moderate risk (1 – 2 m/s).
- High risk (above 2 m/s).

The risk of flooding to primary and secondary access routes is presented in Table 8-6.

Table 8-6: Primary and Secondary Access Road Flood Risk Analysis (based on AECOM (2017))

Access Route	Flood Risk Analysis
Primary	The existing road network predominately consists of tarmacadam surfaced roads with unprotected edges. The surface of these roads is more resilient to scour (in low flows where uplift forces on the underside of the tarmacadam surface are nominal), although the edges remain at risk. The threshold where these roads are considered to be at risk is velocities exceeding 1 m/s, as these flows can scour the erodible / softer material forming the edges. AECOM (2017) identified four locations where flow velocities exceed 1 m/s and there is risk to the structural integrity of the primary access roads.
Secondary	The secondary access routes within the site are currently undefined. The formation of these access routes is also undefined, although typically these would consist of either unmade / compacted earth tracks or formal tracks formed from crushed stone. These types of tracks are susceptible to scour,

Access Route	Flood Risk Analysis
	both along their surface and edges, with the threshold of scour occurring as low as 0.5m/s depending upon the formation of the material along either side of the tracks. A review of the flow paths through the wind farm by AECOM (2017) identified several key flow paths which could present potential risks to the secondary access routes. These flow paths would need to be taken into consideration in the design / layout of the secondary access routes.

For the primary access routes, AECOM has recommended that protection to the edges of the highway only will be required, to prevent erosion to the highways from flow passing over the highway. Such mitigation measures are considered to consist of loose stone rip-rap, with the size of the stone sized to suit the predicted peak velocities.

Where secondary access routes cannot be designed to avoid flow routes with flow velocities in excess of 0.5 m/s, AECOM has again recommended engineering mitigation measures such as the use of erosion control stone established in various configurations (AECOM, 2017).

However, if during the construction stage the underlying material is identified to be more resistant to scour, the requirement for these protection measures may be reduced or removed. Where the velocities are less than 0.5 m/s, no erosion protection measures are deemed to be required (AECOM, 2017).

The assessment of impact in the following sections is based on the assumption that the recommendations of the AECOM (2017) hydrology and flood risk assessment report will be implemented during the detailed design of the Park.

Flow Paths

There are no well-defined flow paths across the plateau within the developable area of the Park. The majority of flow paths on the plateau are defined as minor and the only major wadis are located on the edge of the plateau, particularly to the south and east. The flows draining from the plateau form multiple small scale localized wadis around the perimeter of the Park. These drain into more clearly defined major wadi channels off-site. Figure 8-15 shows flow paths calculated on the development site.

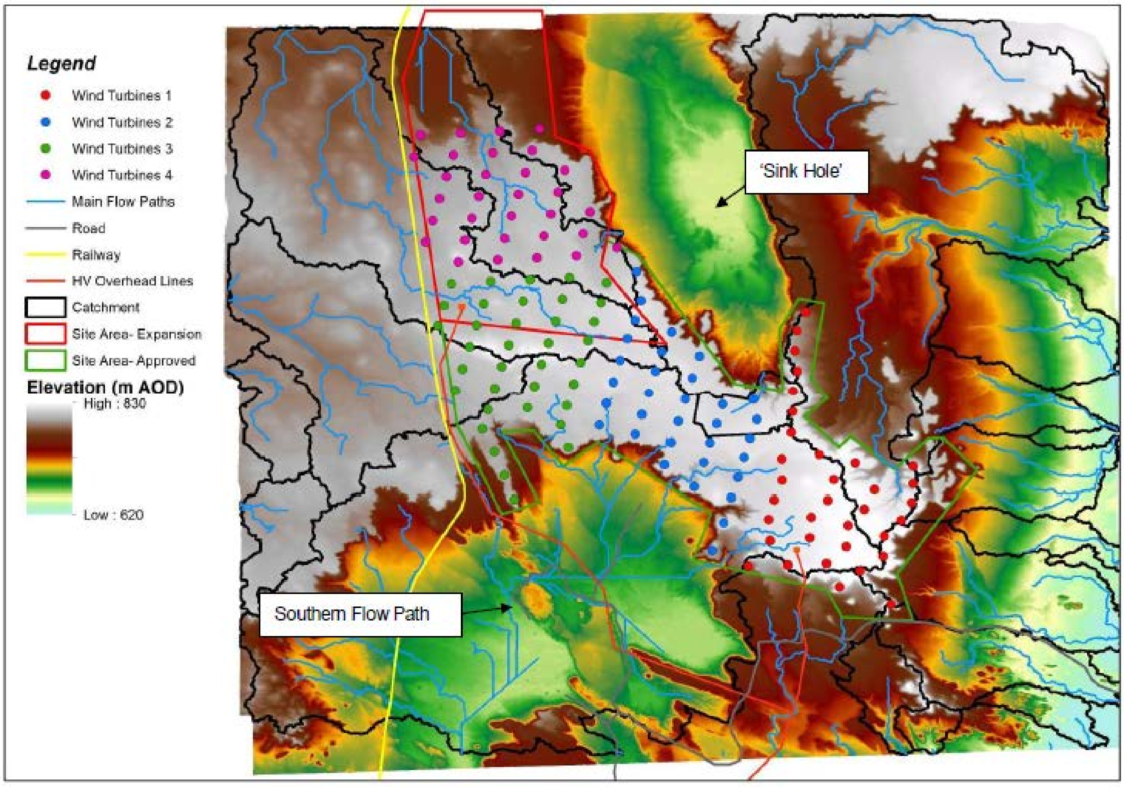

Figure 8-15: Calculated flow paths and catchments for the development site

Implementation of the preliminary design measures will mitigate any potential impacts on the natural hydrogeological function of the wadi channels within the developable area and there will be no impact on the natural patterns of pluvial flows and their discharge off the raised plateau. Nor will the development of the Park impact on any other resources reliant on, or communities who derive direct benefit from this ecosystem service.

8.5 Impact Assessment

8.5.1 Construction Phase

There is potential for impacts of flooding and scour / erosion to the primary access roads, albeit this risk is existing, and secondary access routes within the Park. Similarly there is potential for scour and erosion of turbines. The design of the Park, including the location of construction camps, access tracks and proposed routes of ingress and egress to the development site will be prepared with regard to the data collected during the flood risk assessment, and the measures recommended based upon it. Therefore, any potential impacts either of the Park upon the flood regime, or the flood regime upon the Park, will be avoided or significantly minimized.

During the construction phase of the Park, water supplies will be sourced from local service providers and there will be no groundwater abstraction during construction.

Potential impacts on hydrology and hydrogeology receptors are listed in Table 8-7.

Table 8-7: Construction Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
HH1	Natural flow patterns of the development site	Low	Changes to flow routes and flood risk	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Local Reversible	Low	Low
HH2	Surface Water	Moderate	Contamination of surface water resources	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Long Local permanent	Low	Low

8.5.1.1 Changes to flow routes and flood risk

The development of the Dumat Al Jandal Wind Energy Park could potentially impact upon the flood regime of flow routes within the developable area. Earthworks and the disturbance of soils during the construction of the internal roads, the crane pads and the excavation of foundations for each turbine increase the risk of materials being eroded and washed out during intense rainfall events. Although these materials will be free from contamination, they could potentially exacerbate the effects of scour and erosion to turbines, and primary and secondary roads. In particular the existing culvert on the road to the south of the western boundary of the Park.

Construction activities within flow routes also have the potential to increase the effects of scour and erosion, modify flooding and flood risk, and the mobilization and transportation of soil resources.

However the flood risk assessment has established a clear understanding of drainage channels, flow rates and volumes, and this has been used to inform the assessment of risk during the construction phase. Construction compounds, plant and equipment will be located beyond the influence of known flow routes. Furthermore, there will be no temporary storage of materials or material stockpiles within or adjacent to known flow routes.

Due to the infrequent nature of storm events and the design considerations which have already been made for the construction phase, impacts on flow routes and flood risk are assessed as low significance.

Impact HH1 – Low Significance

8.5.1.2 Contamination of surface water resources

The risks of spills and leaks and subsequent contamination of the groundwater aquifer during construction are similar to those considered in Chapter 7 *Soils and Geology.* Groundwater was not recorded at the development site and therefore has been discounted from the remainder of the assessment.

All sanitary wastes and hazardous liquids (e.g. diesel fuel) will be stored in compliance with the Section 1.3 *Wastewater and Ambient Water Quality* and Section 1.5 *Hazardous Materials Management* of the IFC EHS Guidelines and the GAME Environmental Standard for *Industrial and Municipal Wastewater Discharges*. Furthermore, all material and waste storage areas will be located beyond the influence of known flow routes.

Similarly, re-fueling of vehicles and other fluid transfers will only take place in designated areas where there are impervious surfaces, outside of known flow routes. Where hard surfaces have the potential to collect fluids with the potential to impact upon soils or groundwater resources, (such as car parks or fuel storage areas), oil interceptors will be utilized as per the requirements of GAME Environmental Standard 6 - *Storage and Material Reclaim Facilities Design and Operation*. This will prevent the introduction, through infiltration of any harmful fluids into groundwater and hydrological resources.

The washout from cement mixers and the dry mix batching plant will be discharged to a designated containment and evaporation pond. This evaporation pond will prevent ingress and infiltration of washout water to the groundwater.

If there is a requirement for dust damping, water will be supplied by tanker and will achieve the 2006 standards for wastewater reuse in agricultural irrigation issued by the Ministry of Water and Electricity (MWE).

Flow paths on the development site have been identified and analyzed. Pathways to surface water features such as Lake Dumat and the man-made lake to the south of Sakaka have been modelled and analyzed as part of the flood risk report carried out by AECOM (2016). It has been confirmed that these surface water features would not be impacted by the construction, operation or decommissioning of the Park as there is no direct connectivity. There is a drainage basin within the developable area of the Park, located in the north-west corner. Flows from the northern part of the site will drain into this basin, from where they will evaporate and percolate into the surface geology. Local communities are not known to derive any benefit from this basin and seasonal inundation (e.g. enhanced grazing, water supply etc.).

The impact on surface water resources is therefore assessed as being of low significance.

Impact HH2 – Low Significance

8.5.2 Operation Phase

The preliminary design of the Park has taken into account the risk of flooding and the existing flow paths of Wadi as Subayti and its tributaries.

Potential impacts on hydrology and hydrogeology receptors are listed in Table 8-8.

Table 8-8: Operation Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
HH3	Natural flow patterns of the development site	Low	Changes to flow routes and flood risk	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Infrequent Short Local Reversible	Low	Low
HH4	Surface water at the development site	Moderate	Contamination of groundwater / surface water resources	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Rare Short Local Reversible	Low	Low

8.5.2.1 Changes to flow routes and flood risk

The preliminary design of the Park has considered the risks of flooding and the flow routes, and accounted for this in the layout of turbines and the alignment and design of internal access roads. The turbines are positioned outside of known flow routes and away from the edge of the plateau and possible areas of erosion, and as a consequence will not be significantly impacted by flow paths and flow velocities. The preliminary design also includes reinforcement and protection measures against surface water flows. These measures will further protect the infrastructure of the Park from flooding and minimize the effect of infrastructure on flow routes.

The preliminary design has also accounted for the collection and drainage of flood waters from the northern part of the developable area, and has avoided locating turbines or infrastructure in this location.

The majority of the Park's infrastructure (e.g. internal access roads, crane pads) will remain un-sealed and will permit the infiltration of rainfall. Areas of hard-standing will be restricted to the sub-stations and short lengths of internal road. The areas of hard-standing represent a very minor proportion of the total catchment area within which the Park resides. Although storm water run-off will be straight to adjacent areas for drainage, this is not predicted to significantly increase the risk of flooding.

Where fluvial flows are anticipated, the design of the Park has been altered to minimize the interactions between flood regimes and the infrastructure of the Park. Where discharge to land is anticipated (i.e. from areas of hard standing, oil interceptors will be used in order to prevent contamination.

Due to the anticipated implementation of the measures discussed, this impact is assessed as being of low significance.

Impact HH3 – Low Significance

8.5.2.2 Contamination of surface water resources

During the operational phase of the Park there will be no permanent workforce on site, however the substation structures may provide limited storage facilities, including a septic tank. The sanitary wastewater system for the substations will be adequately designed and sized; and the design of the system will be in compliance with Section 1.3 *Wastewater and Ambient Water Quality* of the IFC EHS Guidelines and GAME Environmental Standard for *Industrial and Municipal Wastewater Discharges.* In addition, the septic tank will have secondary containment in accordance with Section 1.5 *Hazardous Materials Management* of the IFC EHS Guidelines.

There will be also a back-up generator in case of a power failure, and a diesel tank will be installed to provide fuel supplies. This tank will again be designed in accordance with Section 1.5 *Hazardous Materials Management* of the IFC EHS Guidelines. This includes secondary containment.

There will no other storage of materials on site during the operation of the wind farm. Further the sub-stations will be located beyond the influence of known flow routes. The impact on surface water resources is therefore assessed as being of low significance.

Impact HH4 – Low Significance

8.5.3 Decommissioning Phase

Impacts experienced during the decommissioning phase of the Park, are expected to be similar to those experienced during the construction phase. These include leaks of stored materials, runoff, and infiltration from accidental discharges.

In addition, the decommissioning of the transformers and sub-stations has the potential for spills and leaks of transformer and insulating oils. Spills and leaks have the potential to be mobilized during periods of rainfall.

Transformer oil is classified as a hazardous waste and this must be disposed of by a fully licensed and approved waste management contractor and facility. Prior to decommissioning, all oils should first be drained. This will minimize the risk for accidental spills and leaks during removal from the site and transit of equipment for disposal. Mitigation is documented under the recommendations for spill response and emergency response procedures (Chapter 21).

8.6 Mitigation and Recommendations

The preliminary design of the Park has considered the risks of flooding and flow routes, and accounted for this in the layout of turbines and the alignment and design of internal access roads. No impacts of moderate or high significance are predicted. The construction, operation and decommissioning phases of the Park will also comply with IFC and GAME environmental standards, avoiding potential impact on hydrology and hydrogeology receptors. No further mitigation is recommended.

Although no moderate or high significance impacts were identified, the following best practice recommendations are made:

8.6.1 Spill Response

The requirements of the IFC EHS Guidance with regard to spill response should be followed, in particular the following section:

- Documentation of availability of spill response equipment sufficient to handle at least initial stages of a spill and a list of external resources for equipment and personnel, if necessary, to supplement internal resources.

8.6.2 Emergency Preparedness and Response

The requirements of the IFC EHS Guidance with regard to emergency preparedness and response should be followed, in particular, the following:

- Maintaining a list of external equipment, personnel, facilities, funding, expert knowledge, and materials that may be required to respond to emergencies. The list should include personnel with specialized expertise for spill clean-up, flood control, engineering, water treatment, environmental science, etc., or any of the functions required to adequately respond to the identified emergency.
- Develop a training plan to address needs, particularly for fire-fighting, spill response, and evacuation.

8.7 Conclusion

The development of the Dumat Al Jandal Wind Energy Park has the potential to both impact upon, and be impacted by pluvial flooding within the developable area of the Park. The hydrology and flood risk assessment undertaken by AECOM has not identified fluvial flooding as a potential risk to the development. The detailed analysis of flow routes and flood risk, and the identification of potential interactions with the Park has allowed for the design to be modified wherever practicable, and for protection measures against scour and erosion to be recommended. These measures significantly reduce the potential for impact. It is important to note, that it is mutually beneficial for the Park to have as little unmitigated impact upon the flood regime as possible, as this results in less ongoing management and simpler construction.

The potential for leaks of harmful fluids into the environment is low due to the proposed application of the relevant standards outlined in previous sections. Furthermore, no groundwater has been identified during the geotechnical investigation and no groundwater is to be extracted in relation to the Park.

8.8 References

ACES (2017) *Detailed Geotechnical Site Investigation for Dumat Al Jandal Wind Farm (CSD 2014_98A). Al Jouf Province – KSA.*

AECOM (2016). Dumat Al Jandal Wind Farm Development Hydrology and Flood Risks Assessment. Phase 2 Report.

Batayneh *et al.* (2012) Assessing groundwater quality of the shallow alluvial aquifer system in the Dumat al Jandal Basin, northwestern Saudi Arabia

Groundwater Management in Saudi Arabia Draft Synthesis Report, Food and Agriculture Organization of the United Nations 2009.

9. Noise & Vibration

9.1 Introduction

This chapter provides an overview of the existing noise conditions present at the proposed Dumat Al-Jandal Wind Energy Park (the 'Park'), and an assessment of the potential adverse noise and vibration impacts that may arise as a result of the proposed development. The assessment considers typical construction and decommissioning activities, along with operational activities. The assessment of emergency or transient conditions are not covered by this assessment.

9.2 Definitions

This section is intended to aid the understanding of some of the terms and parameters used within this chapter of the document.

A sound wave travelling through the air is a regular disturbance in ambient atmospheric pressure. These pressure fluctuations, when occurring at frequencies within the audible range, are detected by the human ear and produce the sensation of hearing. Noise has been defined in a variety of ways and is very much dependent on factors such as the listener's attitude to the source of the sound and their environment, but is essentially any sound that is unwanted by the recipient.

The human ear is sensitive to a wide range of sound levels; the sound pressure level of the threshold of pain is over a million times that of the quietest audible sound. In order to reduce the relative magnitude of the numbers involved, a logarithmic scale of decibels (dB) based on a reference level of the lowest audible sound is used. Also, the response of the human ear is not constant over all frequencies. It is therefore usual to weight the measured frequency to approximate human response. This is achieved by using filters to vary the contribution of different frequencies to the measured level. The "A" weighting network is the most commonly used and has been shown to correlate closely to the non-linear and subjective response of humans to sound. The use of this weighting is denoted by a capital A in the unit abbreviation (i.e. L_{Amax}, L_{Aeq}, L_{A90} etc.) or a capital A in brackets after a dB level (i.e. 3 dB(A)).

Sound Pressure Level: The sound pressure level (L_P or SPL) is the instantaneous acoustic pressure and is measured in decibels (dB). Since the ear is sensitive to variations in pressure, rather than source power or intensity, the measurement of this parameter gives an indication of the impact on people. The SPL is defined as:

$$SPL = 10\log_{10}\left(\frac{p^2}{p_{ref}^2}\right)$$

Where *p* is the rms[6] pressure of the sound in question (in Pascals, Pa) and *pref* is the reference sound pressure, defined as the limit of human audibility ($2\text{x}10^{-5}$ Pa).

L_{eq}: The L_{eq} is defined as the equivalent continuous sound level and is the most widely used parameter for assessing environmental noise. Since this descriptor is a type of average level, it must by definition have an associated time period over which the measurement is referring to. This is often included in

[6] Root mean square sound pressure: the value obtained when squaring multiple instantaneous sound pressure level measurements at a given point, averaging these over the time of a complete cycle, and taking the square root of this average.

the abbreviation in the form $L_{eq,T}$, where *T* is the time period (i.e. $L_{Aeq,\ 5\text{-min}}$). The formula for calculating the Leq is:

$$L_{eq} = 10\log_{10}\left(\frac{1}{t_2 - t_1}\int_{t_1}^{t_2}\frac{p^2}{p_{ref}^2}.dt\right)$$

In practice, since most modern sound level meters are digital and hence take periodic samples of the sound pressure level, the L_{eq} will be the logarithmic average of all the SPL samples taken in the measurement period.

L_{max}: The L_{max} is defined as the maximum rms level recorded during a measurement period.

L_n: The L_n is a statistical descriptor and refers to the level that is exceeded for n% of the time during a particular measurement period. Again, the measurement period that the descriptor refers to is often included in the abbreviation in the format $L_{n,T}$. Two of the most commonly used statistical descriptors used for environmental noise assessments are the L_{90} and the L_{10}.

L_{10}: The L_{10} refers to the level exceeded for 10 % of the measurement period and is commonly used in assessing road traffic noise as it has been found to give a good indication of the subjective human response to this type of noise.

L_{90}: The L_{90} refers to the level exceeded for 90 % of the measurement period and is widely considered to represent background noise, or the underlying noise in an area between noisy events.

Free-field Noise Level: The term “free-field” refers to noise levels that have been measured or predicted in the absence of any influence of reflections from nearby surfaces. In practice, a measurement is considered to be free-field if it was taken at a distance of over 3.5 m from any reflecting surfaces.

Façade Noise Level: This is the noise level measured or predicted at the façade of a building, typically at a distance of one meter, containing a contribution of reflections from the façade itself.

Peak Particle Velocity (PPV): is the instantaneous maximum velocity reached by a vibrating element as it oscillates about its rest position.

9.3 International and National Standards and Guidance

The potential noise emissions from the Dumat Al-Jandal Wind Energy Park are subject to a number of design criteria and standards. Information relevant to noise and vibration emissions and management is identified in the following documentation:

- International Finance Corporation (IFC), *General Environmental, Health, and Safety (EHS) Guidelines*, April 30, 2007 (IFC, 2007):
  - Environmental, Noise (Guideline 1.7);
  - Occupational Health and Safety, Physical Hazards, Noise (Guideline 2.3); and,
  - Construction and Decommissioning, Noise and Vibration (Guideline 4.1).
- International Finance Corporation (IFC), *Environmental, Health and Safety Guidelines: Wind Energy*, August 7, 2015 (IFC, 2015):

- Presidency of Meteorology and Environment (PME) *General Environmental Regulations and Rules for Implementation* (2001), Article Thirteen, 13.3 (PME, 2001); and
- GAME Environmental Standard 3 - *Environmental Noise* (2012).

Additional Standards and guidance that have been considered in this assessment include:

- British Standard 5228, *Code of practice for noise and vibration control on construction and open sites, 2014:*
  - Part 1, Noise (BSI, 2014); and,
  - Part 2, Vibration (BSI, 2014a).
- International Organization for Standardization (ISO) 9613, *Acoustics – attenuation of sound propagation outdoors*:
  - Part 1, Calculation of the absorption of sound by the atmosphere (ISO, 1993); and,
  - Part 2, General method of calculation (ISO, 1996).
- Energy Technology Support Unit (ETSU), ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms*, (ETSU, 1996).
- Institute of Acoustics (IoA), Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise report (GPG), (IOA, 2013).

Ground-borne vibration has the potential to be generated during the construction and, to a lesser extent, operational phases of the Park. However due to the separation distances between the nearest receptors to the proposed development site boundary (≥80 m) and the nearest turbine (≥ 1 km), see Figure 9-2, it is considered unlikely that any significant adverse environmental vibration effects would result from the Park, as such no further consideration has been given to environmental ground-borne vibration impacts, with the exception of those resulting from the movement of heavy vehicles (during construction and decommissioning) along the access routes to the development site.

9.3.1 IFC (World Bank Group) EHS Guidelines (2007)

The IFC guidelines (IFC, 2007) present both environmental and occupational health and safety noise and vibration limit values, and provides guidance for the management of construction noise.

Construction Noise: Section 4.1: The guidelines recommend planning construction activities with local communities or receptors for activities with the greatest potential to generate noise. These activities should be planned for periods where there is the least risk of disturbance. In addition, further mitigation through the use of temporary noise barriers, exhaust mufflers etc. can be implemented through the construction phase to minimize temporary impacts. Routing of vehicles to avoid receptors or communities is also recommended.

Operational Noise (environmental): Section 1.7: *Noise* presents noise level guidelines for environmental noise, providing both one hour ambient noise limits, as reproduced in Table 9-1, and a noise limit of no more than 3 dB above existing background sound levels. Although not explicit within the guidelines, it is common practice to apply a lower absolute noise threshold before considering night change at a receptor location. To this end, the levels quoted in Table 9-1 shall be considered representative of such thresholds.

Table 9-1: Noise level guidelines, free field

	Hourly ambient noise limit $L_{Aeq,1h}$	
Receptor	Daytime 07:00 – 22:00	Night time 22:00 – 07:00
Residential; institutional; educational	**55**	**45**
Industrial; commercial	70	70

Operational Noise (workplace exposure): Section 2.3: *Physical Hazards* presents noise level guidelines for occupational (workplace) noise as both daily average doses and maximum noise levels. These noise limit values shall be adopted during the construction (decommissioning) and operational phases of the development.

9.3.2 IFC (World Bank Group) EHS Guidelines: Wind Energy (2015)

Section 1.1.2 of the IFC *EHS Guidelines*: Wind Energy provides guidance on the assessment of both construction and operational noise effects of Wind Farms.

Construction noise: the 2015 guidelines do not introduce any noise assessment methods or criteria beyond those detailed within the 2007 IFC EHS Guidelines, and indeed go on to state that "*guidance on acceptable levels can be found in the General EHS Guidelines*".

Operational noise: the 2015 guidelines provide details on the mechanisms by which noise may be generated from modern wind turbines, along with some guidance pertaining to noise mitigation measures. The guidelines also introduce the following stages for the assessment of noise effects from wind turbines:

- *"Receptors should be chosen according to their environmental sensitivity (human, livestock, or wildlife).*
- *Preliminary modeling should be carried out to determine whether more detailed investigation is warranted. The preliminary modelling can be as simple as assuming hemispherical propagation (i.e., the radiation of sound, in all directions, from a source point). Preliminary modelling should focus on sensitive receptors within 2,000 meters (m) of any of the turbines in a wind energy facility.*
- *If the preliminary model suggests that turbine noise at all sensitive receptors is likely to be below an L_{A90} of 35 decibels dBA at a wind speed of 10 meters/second (m/s) at 10 m height during day and night times, then this preliminary modelling is likely to be sufficient to assess noise impact; otherwise it is recommended that more detailed modelling be carried out, which may include background ambient noise measurements.*
- *All modelling should take account of the cumulative noise from all wind energy facilities in the vicinity having the potential to increase noise levels.*
- *If noise criteria based on ambient noise are to be used, it is necessary to measure the background noise in the absence of any wind turbines. This should be done at one or more noise-sensitive receptors. Often the critical receptors will be those closest to the wind energy facility, but if the nearest receptor is also close to other significant noise sources, an alternative receptor may need to be chosen.*
- *The background noise should be measured at 10 m height over a series of 10-minute intervals, using appropriate wind screens. At least five of these 10 minute measurements should be taken for each integer wind speed from cut-in speed to 12 m/s"*

9.3.3 GAME General Environmental Standards: Environmental Noise (2012)

Operational Noise: Article IV – *Community Noise* details noise limit values for all noise sources, with the exception of transport sources. It separates receptor areas into three categories according to their noise sensitivity:

A = Sensitive – These areas are designated quiet areas as they hold value as places of worship, important tourist attractions, recreational park land and those areas surrounding hospitals, schools and noise sensitive natural habitats.

B = Mixed – Areas within this category are typically residential properties (including hostels and hotels) and may range from sparse population densities to suburban districts of cities.

C = Non-sensitive –These areas are mixed, often within cities where there is a combination of residential and commercial activities. This designation will also apply to retail and financial districts.

The permitted free field external noise limits for each area designation are reproduced in Table 9-2. It is considered that the surrounding area and potentially sensitive receptors would fall into category B.

Table 9-2: Permitted free field external noise limits for community noise, measured at any noise sensitive property within the appropriate area designation

Designation	Daytime $L_{Aeq,12\text{-}hr}$ 07:00 – 19:00	Evening $L_{Aeq,4\text{-}hr}$ 19:00 – 23:00	Night-time $L_{Aeq,8\text{-}hr}$ 23:00 – 07:00
A	50	45	40
B	**55**	**50**	**45**
C	60	55	50

It is noted that the Designation B noise limits (i.e. 55, 50 and 45 $L_{Aeq,T}$ for day, evening and night periods, respectively) correspond with the noise limits presented within Article V of the PME Standard: *maximum permissible free field noise levels from industrial units in area set aside primarily for industrial facilities* for A3 classification sites, which are described as '*Light industrial, refers to those areas which may be mixed with or adjacent to residential properties where minor manufacturing processes take place'.*

Construction Noise: Article VI – *Noise from construction activities* presents construction noise limits.

Table 9-3 details the general construction maximum permissible façade noise limits contained within the PME document. For the purposes of this assessment the noise levels presented for area classifications A, B and C are deemed appropriate.

Table 9-3: General construction maximum permissible façade noise limits

Area classification	Daytime $L_{Aeq,12\text{-}hr}$ (07:00 – 19:00)	Evening $L_{Aeq,4\text{-}hr}$ (19:00 – 23:00)	Night-time $L_{Aeq,8\text{-}hr}$ (23:00 – 07:00)
A, B, C	**75**	**65**	**45**
D	80	80	80

Note: It should be noted that the table in the PME Standard details "Evening $L_{Aeq,12\text{-}hr}$ (dB) and Night time $L_{Aeq,12\text{-}hr}$ (dB)". It has been assumed that this should be detailed instead as "Evening $L_{Aeq,4\text{-}hr}$ (dB) and Night-time $L_{Aeq,8\text{-}hr}$ (dB)" within the PME Standard.

Receptors are classified as:

A = Quiet areas – These are areas are designated quiet areas as they hold value in terms of them being places of worship , important tourist attractions , recreational park land and those areas surrounding hospitals, schools and noise sensitive natural habitats.

B = Sensitive – Areas designated in this category will typically be dominated by residential properties (including hostels and hotels) and may range from sparse population densities to suburban districts of cities.

C = Mixed – This designation applies to mixed areas often within cities where there is a mix of residential and commercial activities. This designation will also apply to retail and financial districts.

D = Non-sensitive – The final classification of district is a predominantly industrial area where there are few residential properties and commercial premises. This classification also applies to industrial cities and land that is generally unpopulated.

The document also provides guidance on the permissible maximum sound power levels for equipment for use outdoors and can be used as guidance for assessing construction noise levels from construction activities.

9.3.4 British Standard (BS) 5228: 2009+A1: 2014

Construction noise: BS 5228-1: 2009+A1: 2014 '*Code of practice for noise and vibration control on construction and open sites'* (BSI, 2014) provides a database on the noise emissions from individual items of plant and equipment to predict noise from demolition and construction methods. This database of noise sources has been used in the prediction of construction noise levels for the Park. The standard also suggests practical ways to mitigate excessive noise.

In addition to providing noise source data, the Standard also provides two methodologies for the prediction of significance of noise effects during typical construction works, based upon noise change and existing measured ambient noise levels. The evaluation criteria in the methodology used are applicable for residential housing, hotels, buildings in religious use, schools and health or community facilities. However, the assessment of construction noise impacts during construction shall be assessment against the guidance provided within the Saudi Arabian PME *General Environmental Standard*, BS 5228-1 has been used in identifying noise emission source terms and the prediction of construction (and decommissioning) noise levels only.

Construction vibration: with regard to construction vibration, BS 5228-2 (BSI, 2014a) contains guidance on vibration levels in structures from construction works. BS 5228-2 presents guidance for the control of vibration from construction works.

BS 5228-2 provides guidance on the human response to vibration and for predicting human response to vibration in buildings. For construction works, the guidance contained in Table 9-4 is provided:

Table 9-4: Guidance on the human response to vibration levels from BS 5228-2

Vibration Level (PPV)	Effect
0.14 mms^{-1}	Vibration might just be perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mms^{-1}	Vibration might just be perceptible in residential environments.

Vibration Level (PPV)	Effect
1.0 mms^{-1}	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10.0 mms^{-1}	Vibration is likely to be intolerable for any more than very brief exposure to this level.

For building structure response, BS 5228-2 reproduces the advice on vibration levels that could potentially result in building damage given in BS 7385-2:1993 '*Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration*'[7]. The response of a building to ground-borne vibration is affected by the type of foundation, underlying ground conditions, the building construction and the state of repair of the building. Table 9-5 reproduces the guidance detailed in BS 5228-2 on building classification and guideline values for cosmetic building damage.

Minor damage is possible at vibration magnitudes greater than twice those given in Table 9-5, with major damage at values greater than four times the values in the table. BS 7385-2 also notes that the probability of cosmetic damage tends towards zero at 12.5 mms^{-1} peak component particle velocity.

Table 9-5: Guidance on the effects of vibration levels on building structures from BS 5228-2

Type Of Building	PPV in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and Above
Reinforced or framed structures	50 mms^{-1}	50 mms^{-1}
Industrial and heavy commercial buildings		
Un-reinforced or light framed structures	15 mms^{-1} at 4 Hz increasing to 20 mms-1 at 15 Hz	20 mms^{-1}at 15 Hz increasing to 50 mms^{-1} at 40 Hz and above
Residential or light commercial buildings		

Based on the above criteria, a vibration level of 10 mms^{-1} at the nearest sensitive receptor location as a result of construction would be intolerable for residents for any more than a brief exposure, whilst vibration levels above 12.5 mms^{-1} would represent a risk of cosmetic building damage occurring. Therefore, it was considered that vibration levels in excess of 10 mms^{-1} as a result of construction works should be avoided.

In a residential environment, vibration levels of 1.0 mms^{-1} may cause complaints from residents, but can be tolerated if prior warning and explanation has been given. Where vibration levels as a result of construction works exceed 1.0 mms^{-1} at the nearest sensitive receptor locations, consideration would be given to mitigation options to reduce vibration levels where possible.

Figure 3 from '*Transport and Road Research Laboratory (TRRL) Report No RR53 – Ground Vibration Caused by Civil Engineering Works*' (British Steel, 1986) provides a summary of measurements taken by the TRRL which indicates the relative effects of various construction related sources. This figure indicates that, for a heavy lorry on a poor road surface at 4 m, a PPV of 0.3 mms^{-1} is expected, reducing to approximately 0.1 mms^{-1} at a distance of 8 m.

Additionally, the guidance contained within HD213/11 (Highways England, 2011) advises that should the level of vibration at a receptor be predicted to rise to above a level of 0.3 mms-1, or an existing level

[7] British Standard 7385-2: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration

above 0.3 mms-1 is predicted to increase, then this should be classed as an adverse impact from vibration. It should be noted however that this guidance relates to permanent road traffic noise impacts.

9.3.5 International Standard ISO 9613-2 (1996)

IS0 9613 is established as the primary Standard used in the calculation of environmental sound propagation. The Standard is divided into two parts: Part 1 provides a method for calculating the attenuation of sound due to atmospheric effects, while Part 2 provides a general method of calculation for environmental sound propagation.

The noise prediction method described in Part 2 of the standard is general and is intended to be suitable for a wide range of engineering applications where the noise level outdoors is of interest. A joint European Commission research project into noise prediction methods for wind farms found the ISO 9613-2:1996 method to give the best agreement with measured wind farm noise levels at large separation distances for flat, rolling and complex terrain sites.

The method predicts noise levels under metrological conditions favorable to noise propagation from the sound source to the receiver, such as downwind propagation, or equivalently, propagation under a well-developed moderate ground based (surface) temperature inversion as can occur during low wind conditions at night. Downwind propagation conditions are quantified as those where the wind direction is within 45 degrees of line between the turbine and the receiver, at wind speeds in the range 1 - 5 m/s.

Alternatively, the method can be corrected to predict the long term average noise level over a period, often several months, which considers a variety of metrological conditions. However, calculation of the long term average noise level requires statistical meteorological information on wind speed, wind direction and atmospheric temperature gradients.

9.3.6 ETSU-R-97

ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms*, is a method for assessing and rating noise impacts arising from wind farms within the UK. ETSU-R-97, and the Institute of Acoustics Good Practice Guide (GPG), are considered to represent international best practice and supplement the guidance contained within the IFC EHS Guidelines on wind energy.

ETSU-R-97 recommends the application of separate daytime and night time noise limits at the nearest residential properties and indicated that these limits should generally be set relative to the background noise levels at the dwellings. However, in particularly quiet areas where it is not appropriate to use the margin above background approach in order to provide a reasonable degree of protection to the wind farm neighbor, ETSU-R-97 also recommends fixed noise limits. In all cases the ETSU-R-97 noise limits are aimed at protecting the daytime amenity of outdoor areas near dwellings and sleep indoors during the night time.

ETSU-R-97 noise limits are intended to offer a reasonable degree of protection to residents, but do not guarantee inaudibility.

The acceptable noise limits for wind turbine noise at different times of the day are defined in ETSU-R-97. Quiet daytime periods are defined as:

- Every evening between 18:00 to 23:00 hours;
- Saturday afternoon from 13:00 to 18:00 hours; and,
- Sundays from 07:00 to 23:00 hours.

The night time period is defined as 23:00 to 07:00 hours.

For residential properties where the measured quiet daytime (often called amenity hours) period noise levels exceed 30 – 35 dB L_{A90} or during the night time exceed 38 dB L_{A90}, noise limits are derived from background noise levels. The quiet daytime and night time relative noise limits derived from the background noise levels are set to a level 5 dB(A) above the best fit curve to the background noise data for that period over a wind speed range of up to 12 m/s.

At properties in particularly quiet areas where the daytime amenity noise levels may be less than 30 – 35 dB(A), it is generally appropriate to adopt the lower fixed ETSU-R-97 noise limits i.e. 35 - 40 dB(A) daytime and 43 dB(A) night time. The precise choice of the daytime lower fixed level within the range 35 – 40 dB(A) depends on a number of factors:

- The number of noise affected properties;
- The likely duration and level of exposure; and,
- The potential power output of the wind turbine(s).

At night, ETSU-R-97 prescribes an external lower fixed noise limit of 43 dB(A). This is higher than during the day because at night most people are indoors and additional attenuation of wind farm noise is afforded by the building envelope, even assuming an open window. The lower fixed noise limit of 43 dB(A) outside at night is based on achieving an internal noise level of 35 dB(A) within the bedroom with an open window. It should be noted that residential buildings close to the proposed Park are unlikely to benefit from the same level of noise attenuation through the building façade as those within the UK. As such, the night-time assessment criteria presented within ETSU-R-97 are likely to be higher than those described when assessing impacts at rural buildings in Saudi Arabia.

ETSU-R-97 states that "*the $L_{A90,10min}$ of the wind farm is likely to be about 1.5 – 2.5 dB(A) less that the L_{Aeq} measured over the same period*". A precautionary -2 dB(A) correction has been applied to the $L_{Aeq,T}$ noise levels predicted through the noise modelling exercise.

9.3.7 Institute of Acoustics: Good Practice Guide

The Institute of Acoustics *Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* (GPG) which was published in May 2013 and aims to confirm, clarify and compliment the in practice implementation of ETSU-R-97.

While ETSU-R-97 remains the document that sets out UK government policy in relation to wind turbine noise limits, the GPG represents the current good practice in its implementation.

Issues covered by the GPG include:

- stakeholder engagement;
- definition of Study Area;
- a framework for stakeholder engagement;
- survey methodology;
- treatment of measured data;
- appropriate noise prediction methods; and,
- advice for cumulative assessments.

9.3.8 Noise assessment criteria summary

Table 9-6 summarizes the absolute noise thresholds that have been used in the assessment of construction, operational and decommissioning noise and vibration effects.

Table 9-6: Noise and vibration threshold values from applicable Standards and guidance

Standard or guidance	Noise limit value	Comment
PME (operation)	Daytime: 55 dB $L_{Aeq,T}$ Night time: 45 dB $L_{Aeq,T}$	Free-field noise limit at nearby sensitive receptors.
PME (construction)	Daytime: 75 dB $L_{Aeq,T}$ Night time: 45 dB $L_{Aeq,T}$	Facade noise limit, as appropriate, at nearby sensitive receptors.
IFC (operation – criteria applied during preliminary assessment)	Daytime and Night time: 35 dB $L_{A90,T}$	Assumed free-field noise limit at nearby sensitive receptors, as per ETSU-R-97 approach.
IFC (operation)	Daytime: 55 dB $L_{Aeq,T}$ Night time: 45 dB $L_{Aeq,T}$	Free-field. Receptor: residential; institutional; educational.
BS 5228-2 and HD213/11 (construction)	0.3 mms^{-1}	Vibration might just be perceptible in residential environments

The construction and operational noise levels predicted for this assessment are all presented as free-field $L_{Aeq,T}$ levels. Equivalent façade noise levels would typically be 3 dB greater than free-field levels.

The approaches to defining noise limits detailed within ETSU-R-97 have not been adopted for this assessment. ETSU-R-97 requires a detailed understanding of prevailing background sound levels at sensitive receptor locations, under a variety of meteorological conditions, to determine appropriate day and night noise criteria. This assessment instead adopts the broad assessment approach outlined within the IFC EHS Guidelines for wind energy, along with absolute noise thresholds published by the IFC and PME for environmental and community noise. The assessment does consider the guidance contained within ETSU-R-97 regarding the context of noise impacts arising from wind farms, including the numbers of properties affected (i.e. community response).

9.4 Baseline Environmental Conditions

9.4.1 Baseline Review

No previous noise related studies were identified for the development site and therefore the baseline review of noise data at the development site was carried out using desktop analysis and a preliminary baseline sound level monitoring exercise.

9.4.2 Baseline Survey - Methodology

Sound level monitoring was undertaken at two locations considered representative of noise and vibration sensitive receptors with the potential to experience adverse impacts as a result of the Park. Locations were identified through desktop study.

Table 9-7: Baseline sound level monitoring survey details

Survey Date/Time	Location	Comment
14.12.2016 (morning and afternoon) Morning: 07:43 – 09:43 Afternoon: 13:10 – 15:10	Location 1 Approximately 400 m south of the development site boundary at the foot of the plateau on which the development will be located. Measurement location is in close proximity to an occupied farm (320 m west of the monitoring location).	▪ Intermittent goat and dog sounds ▪ Very occasionally bird song ▪ Voices in the distances ▪ High wind during afternoon survey (5 - 7.5 m/s)
14.12.2016 Morning: 11:23 – 12:23	Location 2 Northern edge of Dumat Al-Jandal.	▪ Cars driving fast and skidding around the roundabout next to the sound level meter. The road looked quite worn in this location, suggesting this practice may be a regular occurrence. ▪ General construction noise in the town ▪ Traffic noise ▪ Dog barking ▪ High wind during afternoon survey (5 - 7.5 m/s)

Baseline noise data were measured using a Rion NL-32 sound level meter. The instrument had received a full manufacturer calibration within 12 months of the survey. In addition, field calibration was undertaken at the start and finish of every survey. No drift in calibration was noted at the end of any of the surveys. Appendix B presents the manufacturer calibration certificate for the sound level meter.

The microphone was placed on a tripod, at a height of 1.5 m above ground level under free-field conditions. The attended survey collected continuous sound level data at 15 minute intervals during one morning, one early afternoon and one late afternoon period to gain a realistic understanding of baseline sound on the development site.

During the survey a sand storm was experienced during a portion of the measurement period, at both locations, with wind speeds exceeding 5 m/s. Review of the sound levels measured during the survey has shown that the sand storm appears to have significantly increased measured baseline sound levels during the afternoon period (at locations 1 and 2), and therefore the data collected in the afternoon, are not considered representative of prevailing baseline sound levels.

Figure 9-1 shows the location of the noise monitoring survey points. Meteorological conditions were recorded for each 15 minute interval of recording (i.e. wind speed, wind direction, temperature and precipitation).

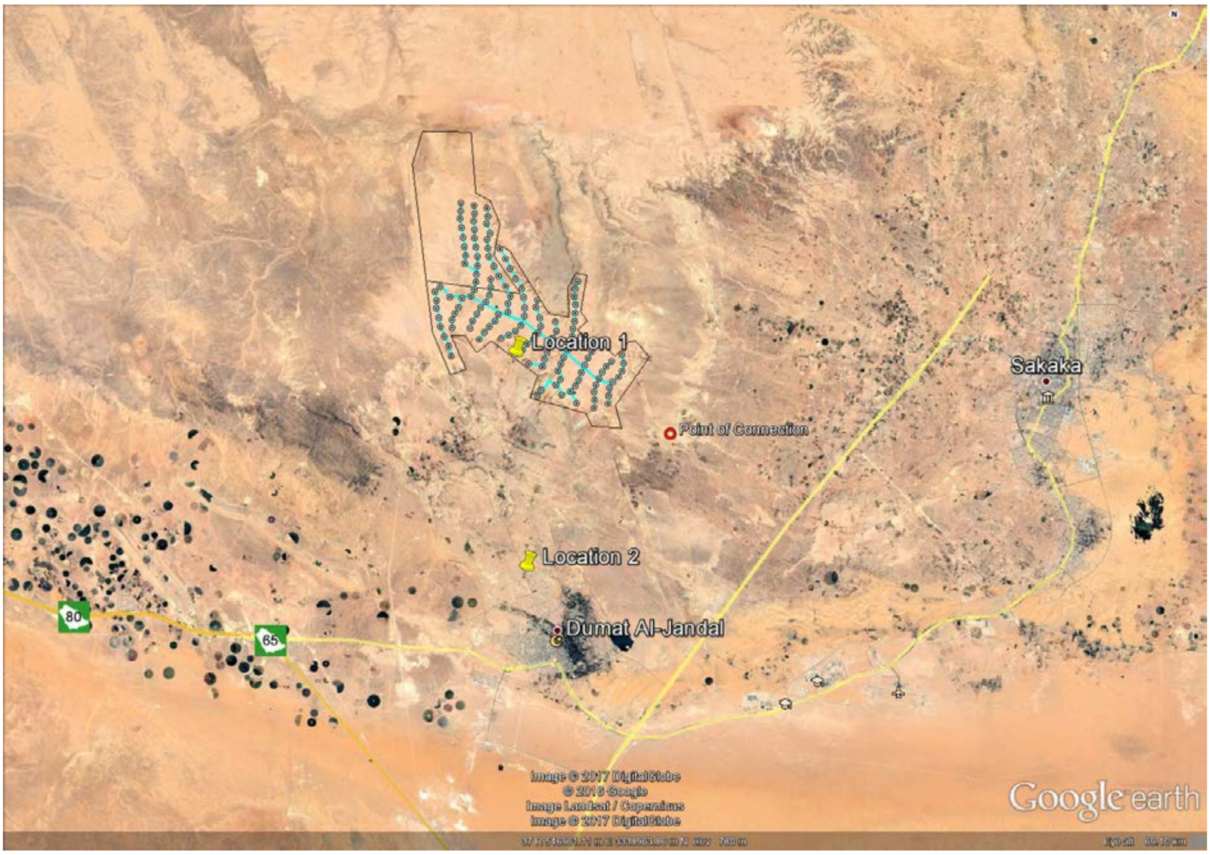

Figure 9-1: Baseline sound level monitoring survey points

9.4.3 Baseline Survey - Results

Table 9-8 presents the sound level monitoring data collected during the baseline survey.

Table 9-8: Measured baseline sound levels, free-field

Location	Averaged Sound Levels			
	$L_{Aeq,2hr}$ (dB)	$L_{Amax,\ 2hr}$ (dB)	$L_{A10,\ 2hr}$ (dB)	$L_{A90,\ 2hr}$ (dB)
Location 1 (am - 07:43 – 09:43)	26	57	27	19
Location 1 (pm – 13:10 – 15:10)*	51	73	54	35
Location 2 (pm – 11:23 – 12:23)*	58	91	53	43

* Averaged sound levels measured during the afternoon periods have been influenced by high winds and the sand storm experienced during the survey and are not considered representative of prevailing baseline sound levels.

Noise data gathered at the baseline monitoring location on the southern boundary of the development site indicates that ambient ($L_{Aeq,T}$) and background ($L_{A90,T}$) sound levels during the morning period were low, being 26 and 19 dBA, respectively.

No significant sources of noise were noted at the development site, and as such the prevailing ambient and background noise levels throughout the day, evening and night-time periods are anticipated to be broadly consistent with those measured during the morning period.

The baseline sound level data presented in Table 9-8 is considered to provide a general indication of prevailing sound levels at the south-western boundary of the development site only. However the baseline sound level monitoring approach adopted here is not considered robust enough to allow for the measured baseline sound level to be used in developing assessment design criteria for the Park.

9.5 Assessment Methodology

The noise and vibration criterion presented in Table 9-6 shall be used in determining the significance of noise and vibration effects through the use of the matrix presented below.

9.5.1 Significance matrix

Defined criteria for assessing magnitude are shown in Table 9-9 (noise) and Table 9-10 (vibration). Table 9-11 shows the decision making matrix for assessing the significance of impacts associated with environmental noise.

Table 9-9: Magnitude definitions for environmental noise impacts

Noise Level at Location of Receptor	Magnitude of Impact
Below or up to applicable noise limits	Negligible
1 to 5 dBA above applicable noise limits	Low
6 to 10 dBA above the applicable noise limits	Moderate
> 10 dBA above the applicable noise limits	High

Table 9-10: Magnitude definitions for environmental vibration impacts

Vibration Level at Location of Receptor	Magnitude of Impact
$\leq$ 0.3 mms^{-1} PPV	Negligible
> 0.3 to 1 mms^{-1} PPV	Low
> 1 to 9 mms^{-1} PPV	Moderate
> 10 mms^{-1} PPV	High

Table 9-11: Decision matrix for significance assessment of environmental noise

Receptor Sensitivity	Magnitude			
	High	Moderate	Low	Negligible
High	High	High	Moderate	Low
Moderate	High	Moderate	Low	Negligible
Low	Moderate	Low	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

9.5.2 Sensitive Receptors

Sample receptors surrounding the proposed wind farm were identified during an initial desktop review exercise, with additional receptors identified following observations made during the baseline sound level monitoring survey. Figure 9-2 illustrates the location of the twelve noise and vibration sensitive sample receptors surrounding the development site. These receptors are described in detail in Chapter 4.

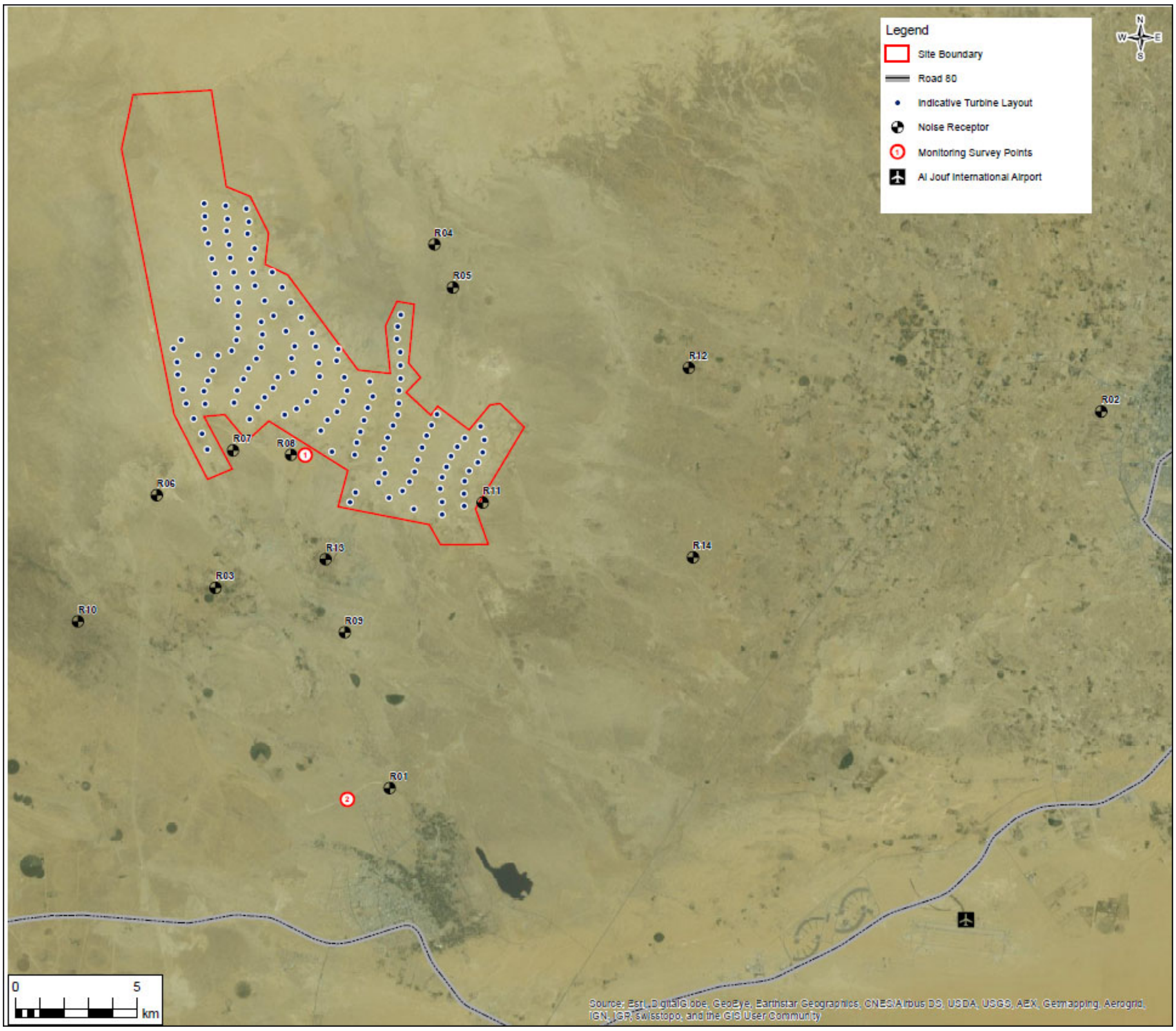

Figure 9-2: Noise receptors included within the noise model for assessment of construction, operation and decommissioning phases of scheme

Seasonal herders were observed in various locations surrounding, and within, the development site boundary during the baseline sound level monitoring survey. The seasonal herder within the development site boundary has since relocated and there is no evidence of any new seasonal herders arriving within, or close to, the Park. These receptors would be excluded from the development sites around the proposed turbines by security fencing during construction, operation and decommissioning of the development. Construction noise levels for seasonal herders have not been quantified, however due to the transient and mobile nature of these receptors potential noise effects would be assessed as low significance.

9.5.3 Assessment Approach

This section discusses the relevant noise modelling configurations settings and conditions.

9.5.3.1 Noise Model Set-up and Configuration

Noise modelling has been undertaken to predict noise levels radiating from the development site. Noise modelling predictions have been made using the CadnaA noise modelling software package, developed by Datakustik. This software package has been configured to utilize the noise propagation algorithm within BS 5228 part 1 (BSI, 2014) for the prediction of construction and decommissioning noise levels, while ISO 9613 parts 1 (ISO, 1993) and 2 (ISO, 1996) have been used in predicting noise levels resulting from the operational scenario that has been considered.

The following settings were selected and assumptions were made within the noise model.

General model conditions

- No reflections or reflective surfaces have been included within the noise model.

Meteorological and ground conditions

- Flat ground has been assumed through the noise model.
- Acoustically reflective ground has been assumed throughout the noise model (α=0.0).
- Noise predictions have been made with an assumed mean ambient air temperature of 20 ^{0}C and an assumed mean relative humidity of 50 %.

Sensitive receptors

- All noise predictions have been made under free-field conditions with receiver points located 1.5 m above ground.

9.5.3.2 Noise sources

Construction and decommission:

Nine construction activities and two decommissioning activities have been considered within this chapter. The activities are listed within Table B 1, Appendix C.

A total of five activities have been included in the noise modelling exercise. The activities selected, and reasons for their selection, are shown below:

- The two construction activities with the highest noise emission (installing foundations for turbines and installing cabling) were included within the noise modelling exercise. These represent the worst-case construction noise emissions at the turbines;

- The breaking and removal of concrete was considered as a decommissioning noise modelling activity. This activity represents the worst-case decommissioning activity for noise emission; and,
- A simple noise modelling exercise was also undertaken to allow for the assessment of the power supply at the construction site and the concrete batching plant. The location of these sources is not known at this stage, and as such the modelling approach considered the predicted noise levels at varying distances from the construction plant and equipment in relation to the applicable noise limits.

The construction/ decommissioning activities (with the exceptions of the power supply and concrete batching plant) included the creation of an area noise source to represent the likely plant and machinery that will be operational within either the south-western, central or northern-most part of the site. Noise sources have been assigned a height of 2 m above ground. It is assumed that all construction/ decommissioning activities shall be undertaken during daytime periods only.

A contractors' compound will be created within the scheme boundary during construction. Construction contractors will sleep within accommodation at the compound during the night. Although construction shall not take place at night, the site will house two proposed 500 kV power supply generators that will operate throughout the night-time period. As such the assessment considers noise levels at the worker accommodation, resulting from the operation of two generators, at varying distances from the generators, with recommendations made based on the findings.

A similar assessment has been performed on the operation of the concrete batching plant. The batching plant shall operate during the daytime period only; nevertheless consideration has been given to the potential for noise at the site offices and worker accommodation during the daytime period.

The assessment of noise impacts due to the movement of heavy vehicles on access roads to and from the facility involves the prediction of noise levels using the haul route calculation method detailed within BS 5228-1 (BSI, 2014). It is assumed that deliveries, as with other construction activities, would be during daytime periods only.

Table B 1, Appendix C presents the combined sound power levels for each of the activities considered in the assessment while Table C 1, Appendix D presents the data pertaining to the assessment of vehicle movements.

Operation:

The first phase of development at the Park is proposed to include 132 turbines. The specification and supplier of the turbine have yet to be selected, and as such the assessment approach adopted here provides a worst-case approach based on currently available outline scheme design details. Details of the candidate turbine selected for inclusion within this assessment can be found in Appendix E.

Each of the turbines is represented as a single point source within the noise model, with hemispherical noise propagation characteristics assumed for each of the turbines. The sources have each been positioned at the assumed hub height of the turbine (155 m above ground).

9.6 Impact Assessment

Table 9-12 presents the indicative noise levels at varying distances from roads due to the movement of heavy vehicles during the construction (and decommissioning) phases of the Park. Table 9-13 presents the construction, operational and decommissioning noise levels predicted at each of the sample receptor locations considered within this assessment as a result of activities within the proposed development site.

As discussed previously, ground-borne vibration effects resulting from construction, operation and decommissioning activities, with the exception of heavy vehicle movements along access routes to the development site, are not anticipated to result in any significant effects and have not been assessed within this section of the chapter.

Table 9-12: Indicative predicted construction noise levels due to vehicle movements on access roads to and from site, free field

Distance (m)	Noise Level ($L_{Aeq,T}$)
4	65
5	64
10	61
20	58
50	54
100	51
200	48
500	44

Table 9-13: Predicted construction, operation and decommissioning noise levels due to on-site activities, free field

Receptor			Predicted activity noise level ($L_{Aeq,T}$), free-field			
ID	Name	Distance to development boundary	Installation of Foundations (BS 5228)	Installation of Cables (BS 5228)	Breaking and removing concrete (BS 5228)	Operational Wind Turbine noise (ISO 9613)
R01	Dumat Al-Jandal	10.1 km	36.6	33.5	44.3	20.9
R02	Sakaka	23.7 km	30.3	27.2	37.9	<20
R03	Farm	4.5 km	40.0	36.8	47.6	28.6
R04	Settlement	2.6 km	41.6	38.4	49.2	31.7
R05	Settlement	1.7 km	43.3	40.1	50.9	33.8
R06	Farm	2.3 km	43.1	40.0	50.8	32.8
R07	Settlement	230 m	47.9	44.7	55.5	41.5
R08	Settlement	590 m	50.0	46.9	57.7	41.6
R09	Human Receptor	5.0 km	41.7	38.5	49.3	28.8
R10	Farm	7.9 km	36.8	33.7	44.4	23.2
R11	Human Receptor	80 m	51.2	48.1	58.8	44.3
R12	Human Receptor	7.1 km	38.0	34.9	45.7	23.0
R13	Farm	2.2 km	44.8	41.6	52.4	34.0
R14	Settlement	8.4 km	37.8	34.6	45.4	22.2

9.6.1 Construction Phase Impacts

Construction of the Park was expected to start in Q2 2017 and will take approximately 20 months. Each phase of the Park is expected to be in operation for 25 years.

Impacts expected to be experienced during the construction phase of the Park include increased ambient noise and vibration at various receptors due to construction activities at the development site.

Table 9-14: Construction Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
N01	Permanent residential properties (assessment focuses on worst-case receptors: Farm (R11) close to south-eastern site boundary, and the settlements (R06 and R07) close to the south-west boundary of the site, approximately 1 km from the nearest turbine)	High	Increased noise levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Negligible	Low
N02	Workers at construction compound	High	Increased noise levels due to the site power supply (generators) and concrete batching plant	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Negligible *if generators and concrete batching plant are located at least 400 m and 300 m, respectively, from the workers' compound*	Low
N03	Sensitive receptors along access roads to site	High	Increased noise levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Negligible, *at a distance of 4 m or greater*	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
N04		High	Increased vibration levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Negligible, *at a distance of 4 m or greater*	Low

9.6.1.1 Increased noise levels (residential properties)

Ambient noise levels are expected to increase during the construction phase of the Park. There are relatively few occupied properties within the vicinity of the Park. The nearest sensitive occupied properties are the settlements to the south-west of the site boundary (R07 and R08), and the farm located south-east of the site boundary (R11). Receptors R07, R08 and R11 are approximately 1 km from the nearest turbine and between 400 m and 80 m (in the case of R11) from the development site boundary. During the construction the R11 receptor is predicted to experience a noise level of 51 dB $L_{Aeq,T}$ free-field (equivalent to 54 dB $L_{Aeq,T}$ at the façade of the property). Lower construction noise levels would be anticipated during other phases of construction. The GAME (formerly known as the PME) provides a construction noise guideline limit value of 75 dB $L_{Aeq,T}$ at the façade of noise sensitive receptors during daytime construction, and as such this effect is assessed as Low significance.

Impact N01 – Low Significance

9.6.1.2 Increased noise levels (construction workforce)

There is the potential for significant adverse effects as a result of noise emissions from the proposed generators and concrete batching plant at the workers' compound.

Generators: the generators shall operate during the day and night. The combined sound power level of the generator sets is 105 dB L_{WA}. The noise emission from the generators are predicted to exceed the 45 dB $L_{Aeq,T}$ night-time noise limit value at a distance of <400 m.

A minimum offset distance between the generators and worker accommodation of 400 m should be maintained to ensure that façade noise levels do not exceed 45 dB $L_{Aeq,T}$ at night. The effect is assessed as Low significance if the minimum offset distance of 400 m is maintained. If this is not possible then consideration should be given to possible noise controls at source, such as the provision of a suitable acoustic enclosure.

Concrete batching plant: the concrete batching plant shall operate during the daytime only. The combined sound power level of the batching plant is 111 dB L_{WA}. The noise emission from the batching plant are predicted to exceed 55 dB $L_{Aeq,T}$ daytime noise limit value at a distance of <300 m.

A minimum offset distance between the batching plant and workers compound of 300 m should be maintained to ensure that façade noise levels do not exceed 55 dB $L_{Aeq,T}$ during the day. The effect is assessed as Low significance if the minimum offset distance of 300 m is maintained.

Impact N02 – Low Significance

9.6.1.3 Increased noise levels (receptor communities: vehicle traffic)

Ambient noise levels are expected to increase during the construction phase of the Park, as a result of vehicle movements to and from the development site. However the assessment (see Table 9-12) demonstrates that construction noise levels resulting from heavy vehicle movements are below the daytime construction noise limit, even at very small source to receiver offset distances, and the effect is therefore assessed as Low significance.

Impact N03 – Low Significance

9.6.1.4 Increased vibration levels (receptor communities: vehicle traffic)

Ground-borne vibration levels are expected to increase during the construction phase of the Park, as a result of vehicle movements to and from the development site. However, as discussed within Section 9.3.4, vibration effects beyond 4 m from a road are assessed as being of Low magnitude and significance in this context.

Impact N04 – Low Significance

9.6.2 Operation Phase Impacts

Impacts expected to be experienced during the operational phase of the Park relate to the increase in noise and vibration associated with the general operation of the Park (Table 9-15).

Table 9-15: Operational Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
N05	Permanent residential properties (assessment focuses on worst-case receptors: Farm (R11) close to south-eastern site boundary, and the settlements (R06 and R07) close to the south-west boundary of the site, approximately 1 km from the nearest turbine)	High	Increased ambient noise levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Occasional Duration: Long Extent: Local Permanence: Reversible	Moderate	High

9.6.2.1 Increased noise levels (residential properties)

Operational noise effects have been assessed against the assessment approach set out within the IFC *EHS Guidelines: Wind Energy*. Table 9-13 presents the predicted operational noise levels at the nearest noise sensitive receptors. The worst affected receptors are the R07 and R08 settlements and the R11 farm. Predicted ambient free-field noise levels at these receptors range from 42 – 44 dB $L_{Aeq,T}$, which equate to an L_{A90} noise level of between 40 – 42 dB L_{A90}. The derived L_{A90} wind turbine noise levels are predicted to exceed the 35 dB L_{A90} noise limit presented within the IFC *EHS Guidelines: Wind Energy*. Based on the initial assessment, noise levels from the facility are predicted to exceed the criterion by as much as 8 dB and there is a high likelihood of significant effects.

Noise mitigation shall be considered at receptors R07, R08 and R11, which is discussed within section 9.7.2, below.

Impact N05 – High Significance [See Mitigation section and Conclusions and Recommendations section]

9.6.3 Decommissioning Phase

Table 9-16: Decommissioning Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
N06	Permanent residential properties (assessment focuses on worst-case receptors: Farm (R11) close to south-eastern site boundary, and the settlements (R06 and R07) close to the south-west boundary of the site, approximately 1 km from the nearest turbine)	High	Increased ambient noise levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Occasional Duration: Long Extent: Local Permanence: Reversible	Negligible	Low

9.6.3.1 Increased noise levels (residential properties)

Ambient noise levels are expected to increase during the decommissioning phase of the Park. As previously discussed, the nearest sensitive occupied properties to the development are the settlements to the south-west of the site boundary (R07 and R08), and the farm located south-east of the site boundary (R11). Receptors R07, R08 and R11 are approximately 1 km from the nearest turbine and between 400 m and 80 m (in the case of R11) from the development site boundary.

During the decommissioning of the Park the R11 receptor is predicted to experience a noise level of 59 dB $L_{Aeq,T}$ free-field (equivalent to 62 dB $L_{Aeq,T}$ at the façade of the property). Lower noise levels would be anticipated during other phases of decommissioning. The GAME provides a construction noise guideline limit value of 75 dB $L_{Aeq,T}$ at the façade of noise sensitive receptors during daytime construction, and as such this effect is assessed as negligible significance.

Impact N06 – Low Significance

9.7 Mitigation

9.7.1 Construction Phase

The assessment demonstrates that the likelihood of significance adverse effects during construction is low. Nevertheless all work would be undertaken with due regard for best practice methods and control measures, including (but not limited to) to the guidance presented within the PME Standards and IFC Guidelines. Article VII – *Noise from vehicles*, and article VIII – *Noise from equipment used outdoors* detail permissible noise levels from plant and equipment.

The good practice recommendations presented within the IFC Guidelines are presented below.

"Noise reduction options that should be considered include:

- *selecting equipment with lower sound power levels;*
- *installing silencers for fans;*
- *installing suitable mufflers on engine exhausts and compressor components;*
- *installing acoustic enclosures for equipment casing radiating noise;*
- *improving the acoustic performance of constructed buildings, apply sound insulation;*
- *installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective;*
- *installing vibration isolation for mechanical equipment;*
- *limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas;*
- *re-locating noise sources to less sensitive areas to take advantage of distance and shielding;*
- *siting permanent facilities away from community areas if possible;*
- *taking advantage of the natural topography as a noise buffer during facility design;*
- *reducing project traffic routing through community areas wherever possible;*
- *planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas;*
- *developing a mechanism to record and respond to complaints";*

In addition to the example of good practice presented above, BS 5228: 2009 + A1: 2014 - Parts 1 and 2 provide further guidance on effective methods for controlling noise and vibration emissions. It is anticipated that the following mitigation measures would be employed on site to ensure that noise and vibration levels are adequately controlled (all of which are considered to be examples of Best Practicable Means (BPM)):

- appropriate selection of plant and equipment, construction methods and programming. Only plant conforming with or better than relevant national or international standards, directives or recommendations on noise or vibration emissions will be used. Construction plant will be maintained in good condition with regards to minimizing noise and vibration emission;

- plant will be operated and maintained appropriately, with due regard for manufacturer recommendations;
- all vehicles, plant and equipment will be switched off when not in use;
- use of appropriate noise abatement site hoardings and screens, where appropriate. Where practicable, gates will not be located opposite noise sensitive receptors;
- careful selection of routes and programming for the transport of construction materials, spoil and personnel so as to reduce the risk of increased noise and vibration impacts during construction;
- vehicle and mechanical plant/ equipment used for the purpose of the works should be fitted with effective exhaust silencers, to be maintained in good working order and operated in such a manner so as to minimize noise emissions;
- the positioning of construction plant and activities to minimize noise at sensitive locations;
- equipment that breaks concrete by munching or similar, rather than by percussion, will be used where practicable;
- mufflers shall be used on pneumatic tools;
- the use, where necessary, of effective sound reducing enclosures;
- programming works so that the requirement for working outside normal working hours is avoided;
- minimize the potential for higher vibration levels from the vibratory roller (used within the installation of access roads activity), by taking into account the guidance within TRL report 429 (ensure that the vibratory roller is not started, stopped, or the direction of travel reversed close to sensitive receptors). TRL report 429 (Hiller & Crabb, 2000) states that:

  "…it should be remembered that for vibrating rollers there are likely to be transients at starting and stopping which may generate particle velocities which can be twice as large as for steady state operation. Significantly lower speeds than the 1.5 to 2.5 kph specified will also result in higher particle velocities. The implications of this are that rollers should not be started, stopped, or the direction of travel reversed near to sensitive structures."

It is anticipated that a schedule of noise and vibration monitoring would be agreed with regulatory body and noise and vibration limits be included within the Environmental Management and Monitoring Plan (EMMP) agreed.

It would be expected that the contractor shall endeavor to undertake construction works during daytime periods only, avoiding the potential for adverse impacts at night and weekends.

The assessment that has been undertaken is considered to be generally conservative in its approach. The assessment assumed that all plant and equipment included within a discrete construction activity shall be in operation at the same time and with an operating time of 90 % during the assessment period.

9.7.2 Operation Phase

The examples of good practice presented within the IFC EHS Guidelines for Wind Power, as outlined above, shall be adopted where reasonably practicable.

The potential for significant effects have been predicted at the R07 and R08 settlements and the R11 farm. The abatement/ mitigation approach outlined within Section 5 of the ESIA shall therefore be adopted in order to reduce these noise effects.

The turbine layout considered within this chapter, and throughout the ESIA, is based on the current Park design, which may change prior to a final design fix and noise modelling assessment. The proposed turbines to be installed are also not known at this time and as such the noise assessment is based on a conservative assumption of turbine selection with regard to noise emission. During the next phase the IPP will be required to undertake the noise assessment once these design issues have been developed, and the results of the assessment presented in an addendum to the ESIA, including proposed mitigation measures as appropriate. Potential noise mitigation/ abatement options for operational noise effects which can be considered include:

- The siting of turbines within the development site to ensure a maximum off-set distance between the turbines and receptors. An indicative assessment, which has considered the number of turbines within the current design that would need to be disabled in order to achieve the IFC assessment criterion, is presented below. The assessment demonstrates that due to the number of turbines within relatively close proximity to the nearest sensitive receptors, noise control via repositioning of turbines alone is likely to be impractical. However such design alterations shall be considered alongside turbine selection in order to reduce noise effects as far as reasonably practicable.

Where all mitigation measures within the design have been considered and incorporated, and where noise impacts are still considered to be moderate or above, further mitigation and compensation shall be considered. This shall be undertaken using appropriate consultation with the individual receptors, as required by the Equator Principles and IFC Performance Standards 4 and 5, and according to the Stakeholder Engagement Plan. Measures may include:

- The installation of glazing at the receptors to reduce noise transmission into the properties.
- Compensation for the nuisance – sufficient for example to allow the receptors to live away from properties while still being able to work at their property (e.g. the farm).
- Resettlement. The full resettlement of the household(s) and or business shall be viewed as an option of last resort but shall be considered if alternative noise mitigation measures, as outlined above, provide an insufficient level of noise protection.

Requirements for Compensation and/or resettlement are detailed in Chapter 14 Socio-economics.

Disabling turbines; further indicative testing within the noise model was undertaken to ascertain the number of turbines that would need to be disabled (thereby removing any noise emission from the turbine) to ensure that the 35 dB L_{A90} noise limit presented within the IFC *EHS Guidelines: Wind Energy* is not exceeded. Testing was undertaken at the worst-affected receptors – R07, R08 and R11. The testing demonstrated that a total of 32 turbines would need to be disabled (close to receptors R07, R08 and R11) to achieve a predicted level of <35 dB $L_{A90,T}$, which equates to approximately 25% of the turbines at the Park. It should be noted that the noise propagation algorithm detailed within ISO 9613-2 (ISO, 1996) adopts generally conservative propagation conditions, including slight downwind conditions from all noise sources (i.e. turbines) within the noise model at each receiver.

Turbine noise emission; noise emissions should be considered when selecting the turbines to be installed at the development site. The General Electric (GE) 3.8 MW turbine (3.8-130) selected as a candidate wind turbine for the assessment has a quoted sound power level of 106.5 dBA under normal operation. The manufacturer states that reduced noise modes available are available; however, no details on likely noise emissions under such conditions are provided (GE, 2016). Reduced noise modes may be utilized during periods of higher wind speeds, i.e. those periods during which noise emissions from the turbines shall generally be highest.

When selecting a turbine for the Park, consideration should be given to the noise emission of the turbine. The assessment demonstrates that the IFC assessment criterion has been exceeded by as much at 8 dB.

It is unlikely that turbines of the size that are proposed to be installed at the Park will be available with an operating condition that results in a sound power level of 98.5 dBA or lower. As such, consideration shall be given to both the sound power level of the turbines and the siting of turbines within the final mitigation strategy. This mitigation strategy shall be considered within the detailed noise modelling and assessment that shall be undertaken when further design details are available. This assessment shall be presented within an addendum ES.

9.7.3 Decommissioning Phase

The control of noise and vibration effects during the decommissioning phase of the development will follow the examples of good practice adopted during the construction phase of the scheme.

9.7.4 Workplace noise and vibration

Workplace noise exposure during construction and decommissioning, and to a lesser extent operation, of the Park will be controlled through the adoption of good practice, some examples of which are presented within the Occupational Health and Safety section of the IFC guidelines (IFC, 2007).

The noise limits for working environments, of the IFC guidelines (see Table 9-6), shall be adopted.

9.8 Conclusion and Recommendations

The assessment of construction and decommissioning noise and vibration effects associated with the development of the Dumat Al Jandal Wind Energy Park demonstrate that the likelihood of significant effects at nearby noise and vibration sensitive receptors is low. Despite this, it is recommended that the examples of good practice with regard to noise and vibration control be adopted throughout the various stages of the scheme.

The greatest potential source of adverse noise effects during construction/ decommissioning are likely to result from the operation of the generators, and as such it is recommended that these are located as far as reasonably practicable from sensitive receptors and at least 400 m from the proposed contractor's workers compound in the north-western corner of the facility. If this is not possible then consideration should be given to possible noise controls at source, such as the provision of a suitable acoustic enclosure.

The assessment has demonstrated that there is a potential for a significant effects at the closest occupied receptors to the Park during operation. Mitigation options have been considered, with the most viable options likely to include the selection of a low noise emitting turbine (where practicable), the optimal siting of turbines within close proximity to the nearby receptors and the installation of glazing to reduce noise ingress. If this is not practical or does not provide sufficient noise mitigation then consideration shall be given to compensation, with relocation of affected households.

9.8.1 Recommendations

Noise emissions from the Park shall inform the final design stages of the Park. This may include further noise modelling prediction and analysis of design options, which will inform the final scheme design so as to optimize both the siting and selection of turbines. Following this, a detailed assessment of operational noise impacts associated with the proposed wind farm site shall be undertaken once the turbines have been selected and once the number and location of each turbine has been finalized within the final scheme design. The assessment shall follow the principles and approach outlined with the IFC *EHS Guidelines: Wind Energy*. Detailed prediction noise modelling shall be adopted and the assessment approach shall be consistent with that detailed in ETSU-R-97 and IoA GPG. Such an assessment approach would require additional baseline sound level monitoring at the worst-affected noise sensitive receptors identified within this assessment in a range of wind conditions and with concurrent wind measurements. This assessment shall be presented within an addendum ES.

If significant effects are still predicted then mitigation in the form of glazing at the sensitive receptors, compensation for nuisance, and lastly relocation, shall be reviewed.

9.9 References

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10. Landscape and Visual

10.1 Introduction

Landscape and Visual Impact Assessment (LVIA) can be described as '*a tool used to identify and assess the significance of the effects of changes resulting from development on both the landscape as an environmental resource in its own right and on people's views and visual amenity' (Landscape Institute, 2014)*.

The baseline review of the landscape resources and visual amenity which would be potentially impacted upon by the Dumat Al Jandal Wind Energy Park (the Park,) and their subsequent assessment has been carried out using information provided by Saudi Aramco, existing publically available digital mapping and topographical information including Google Earth and fieldwork. The assessment, following the baseline review, has been undertaken in accordance with good practice guidance and addressed impacts associated with both the construction and operational phases of the Park.

The LVIA chapter has been set out in the following sections:

- Section 10.1 Introduction;
- Section 10.2 International and National Standards and Guidance;
- Section 10.3 Baseline Environmental Conditions;
- Section 10.4 Assessment Methodology;
- Section 10.5 Impact Assessment; and,
- Section 10.6 Conclusion.

10.2 International and National Standards and Guidance

No national guidance is available regarding the assessment of landscape and visual impact within Saudi Arabia.

The IFC Good International Industry Practice (GIIP) recommendation is for the use of the *Guidelines for Landscape and Visual Impact Assessment for* the assessment of the landscape and visual impact of international projects. In preparing this assessment, reference has been made to the following guidance:

- *Guidelines for Landscape and Visual Impact Assessment (3rd Edition)* – Landscape Institute and the Institute of Environmental Assessment and Management (2013) (GLVIA 3).
- *Landscape Character Assessment, Guidance for England and Scotland* - The Countryside Agency and Scottish Natural Heritage (2002); and
- *Photography and Photomontage in Landscape and Visual Impact Assessment* - The Landscape Institute, Advice Note 01/11 (March 2011).

These pieces of guidance (originating from the United Kingdom) are commonly adopted in the assessment of renewable energy projects such as the Dumat Al Jandal Wind Energy Park, and the Landscape Institute's guidance is specifically referenced in the IFC's *Environmental, Health and Safety Guidelines for Wind Energy*.

10.3 Baseline Environmental Conditions

10.3.1 The Site

The proposed site of the Dumat Al Jandal Wind Energy Park is located within a non-classified area of an approved Saudi Aramco Land Use Permit (LUP 43980) approximately 15 km to the north of the town of Dumat Al Jandal, in Al Jouf Province, northern Saudi Arabia. The permitted development area covers approximately 71 km^2.

The landform of the development site comprises an exposed, flat and sweeping desert plateau with landform rising gently to the south. The maximum elevation at the southern boundary of the study area is 800 m, and at the northern boundary, 750 m. The composition of the site is open, with wide, rocky expanses. The ground is sandy, and is littered with rock debris. The development site is bisected to the east by the rail line linking the phosphate mine to the north with the city of Jubail to the east.

10.3.2 The Study Area

The Study Area comprises land that falls within the 35 km radius from the boundary of the development site and is shown in Figure 10-1.

The study area comprises a section of the Al Nafud desert to the south, an area of settled desert plain in the center, and to the north, an area of desert plateau. The Al Nafud Desert is characterized by sweeping sandy desert, at typical elevations of between approximately 650 and 700 m. The desert plateau is characterized by flat, rocky plains, at higher typical elevations of between approximately 750 and 800 m. The settled desert plain between the two typologies of the study area is comprised of an area of lower elevation characterized by the pattern of wadi channels and steep valley sides which may represent the presence of an extinct lake. Agricultural settlements exist in this area as well as larger towns such as Sakaka and Dumat Al Jandal which located in the area due to the fertile soils and potential for farming.

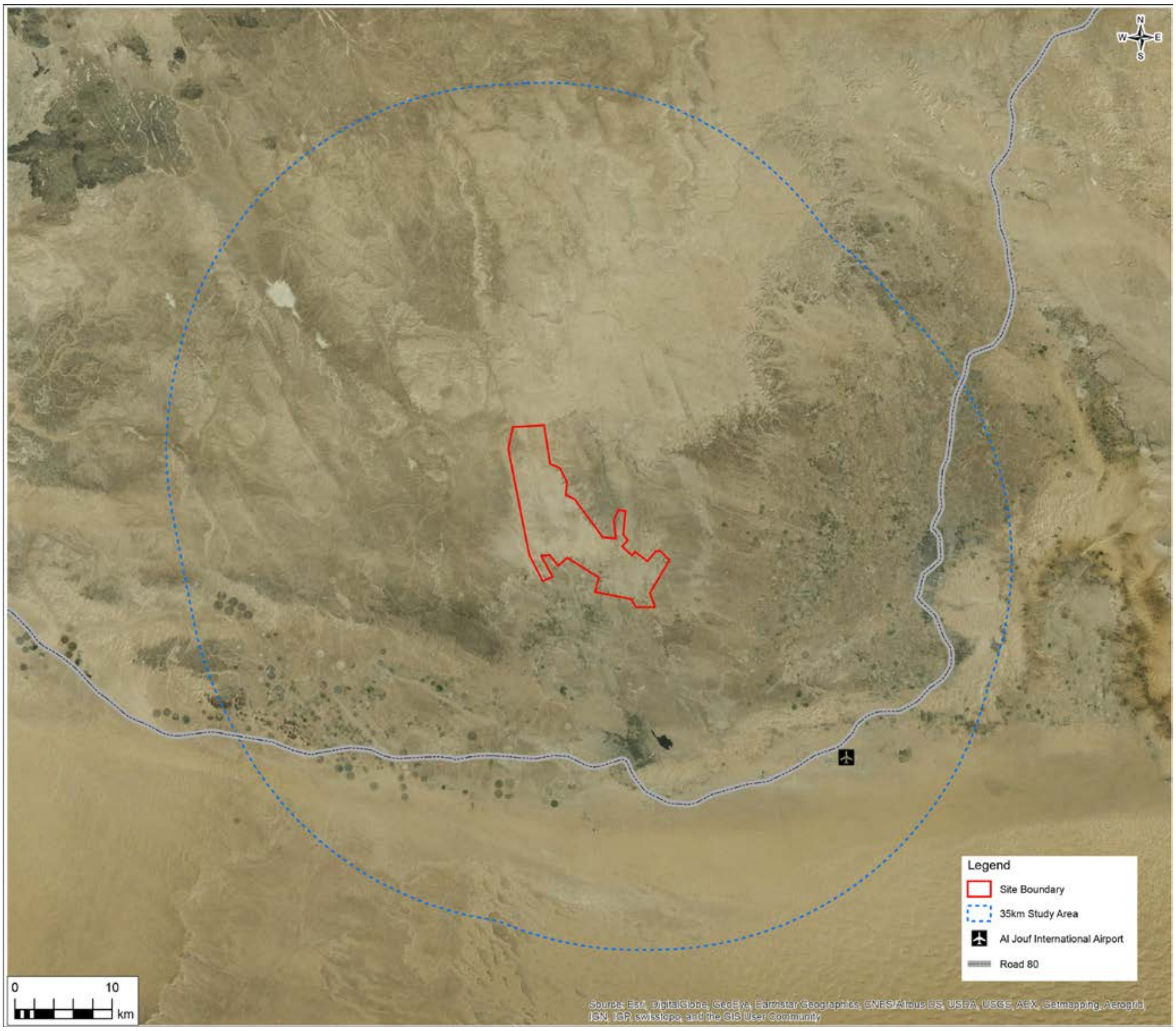

Figure 10-1: Study Area

10.3.2.1 Landscape Elements and Land cover

The three distinct types of landscape within the study area exhibit very different characteristics. The desert plain, to the south consists mainly of rugged desert terrain, rough rocky desert with very sparse vegetation, very gentle landform of sweeping dunes shaped by the action of wind, and long range views across vast expanses of desert. The settled desert plain in the center of the study area is more vegetated, being at a lower elevation and closer to groundwater. The majority of vegetation within this part of the study area is maintained by humans, although natural features do exist, such as the lake at Dumat Al Jandal. The desert plateau is again, very sparsely vegetated similar to the desert plain. However, this area comprises the steep wadi channels at its edge, which lead off the plateau and into the landscape below.

10.3.2.2 Geology and Landform

The geology of the development site is predominantly comprised of Jauf formation and Aruma formation, these rock formations consist of limestone, marly limestone and chalky limestone. For full geological details, please refer to chapter 7 *(Soils & Geology).*

The landform of the Study Area is generally flat, albeit at differing elevations.

10.3.2.3 Land Use

The land to the north and south of the Study Area within the desert plateau and the desert plain areas; is predominantly unused due to its harsh desert nature, some recreational camping and seasonal herding activity takes place, but this is limited. In the center of the Study Area, around the settlements of Sakaka and Dumat Al Jandal, land is more inhabited and intensively used. Typical uses within this section of the study area include residential, commercial and agricultural.

10.3.2.4 Existing Infrastructure

Existing infrastructure within the Study Area includes the Al Jouf Bulk Plant which is located approximately 29 km south-east of the development site. This development consists of gas holders, and other petrochemical storage infrastructure. The site is operational during normal day time hours during which time, trucks transport petrochemicals in and out of the site.

Al Jouf Power Station is located approximately 20 km south of the development site. This development consists of power generation and distribution infrastructure, transformers, generators and transmission masts. Overhead electricity transmission lines of various kV ratings convene at the Al Jouf Power Station. A transmission corridor runs east – west approximately 400 m north of the development site, within this corridor are two 132 kV lines, and one 13.8 kV line.

Overhead power lines are present on the border of the development site, in the south eastern portion of the Study Area; these are currently under construction and run from north the Al Jouf Power Station, past the development site and onwards in a north easterly direction.

A gypsum quarry is located approximately 3 km east of the development site boundary. Infrastructure at this quarry consists of batching and mining equipment and plant. As indicated above, the development site is bisected to the east by the rail line linking the phosphate mine to the north with the city of Jubail to the east.

10.3.2.5 Landscape Designations

There is no recognized system of landscape designation within Saudi Arabia. As such the development site is not subject to any form of protection or designation at a national level. Furthermore there are no international designations (such as UNESCO World Heritage Sites) placed upon the development site.

10.3.3 Landscape Character

The Landscape Character Types (LCT) identified within the Study Area following the baseline review include:

- Desert Plain LCT
- Settled Desert Plain LCT
- Desert Plateau LCT

Figure 10-2 shows the landscape character of the development site and its surroundings.

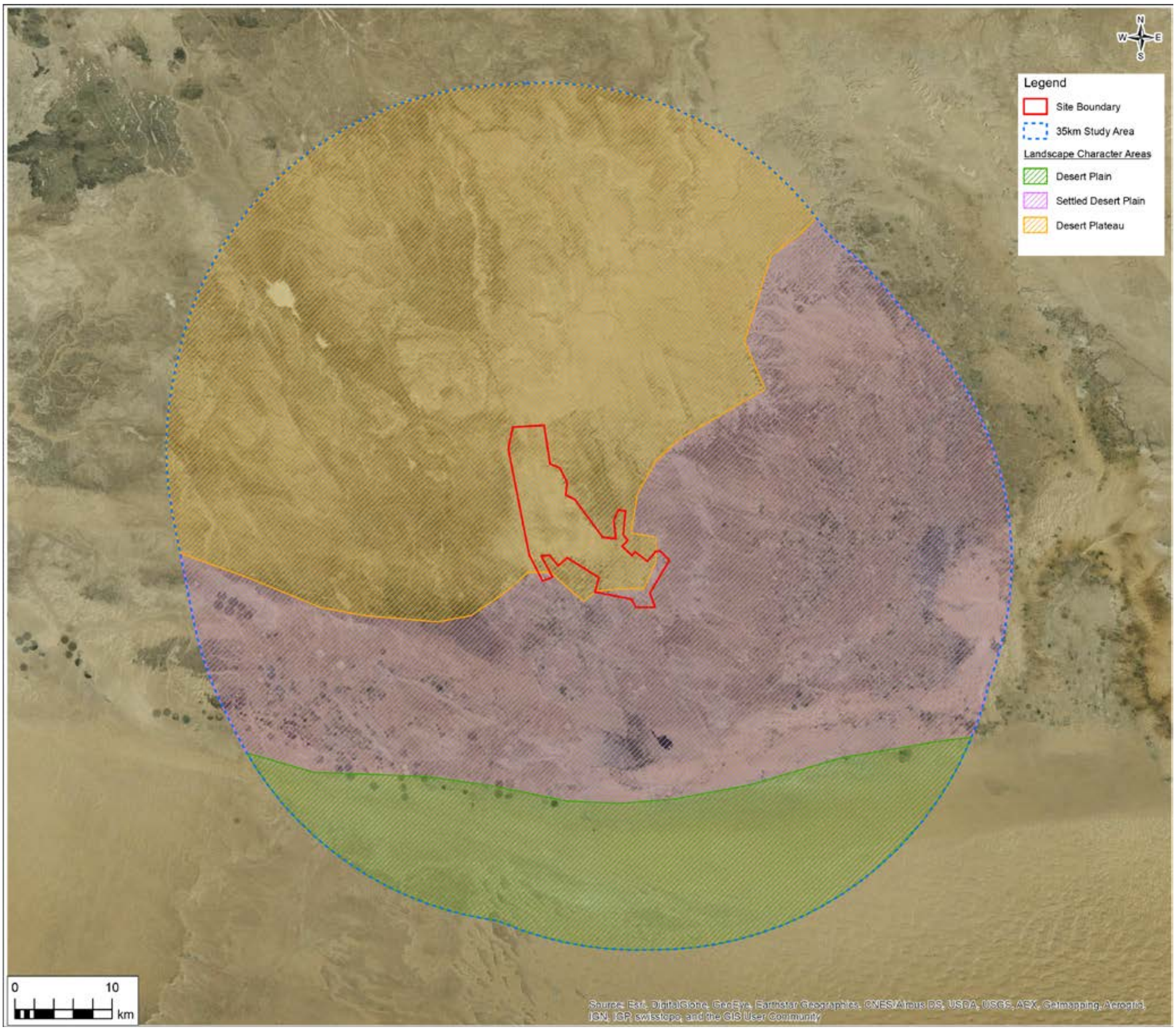

Figure 10-2: Landscape Character Areas of the Site and Surroundings

10.3.3.1 Desert Plain LCT

The Desert Plain LCT comprises the rough sandy desert area to the south of the Settled Desert Plain LCT extending into the Al Nafud desert to the south. This is a very large scale, open LCT with long range views over sweeping desert and very harsh exposed conditions.

Land use within this LCT is limited to nomadic seasonal grazing, herding of animals and power distribution. The topography is flat, and land cover is sparse, with only very occasional scrub.

Key Characteristics

- Very large scale;
- Open long range views;
- Exposed conditions; and

- Very little evidence of human activity.

10.3.3.1.1 Sensitivity to Change

The LCT is defined by its very large scale and the general absence of development. There is a lack of human activity within this LCT, and this simple, undeveloped nature is a key characteristic of the landscape. The introduction of any form of development would alter the character of this LCT to some extent but the very large scale of the LCT and the commonality of desert landscapes throughout the Kingdom infer a low susceptibility to change. Furthermore, while it is recognized that the Al Nafud Desert is located within this landscape character type there is currently no formal designation placed upon this landscape resource. In consideration of this, the LCT has been assessed as being of low value and low sensitivity to change associated with the Park.

Figure 10-3: Rough Desert within the Desert Plain LCT

Figure 10-4: Desert Plain LCT

10.3.3.2 Settled Desert Plain LCT

The Settled Desert Plain LCT is located in the valley like depression which the town of Sakaka and its associated development along Road 80 is sited within. The LCT boundary is defined to the south by the edge of the settled area, where it abuts the undeveloped Desert Plain LCT. To the north, the character type extends as far as the foot of the wadi channels which define the boundary of the Desert Plateau LCT.

Land use within this LCT is a mixture of residential, commercial and industrial developments. Residential areas typically comprise medium density low rise properties (typically of a g+2 configuration). Commercial properties are typically located on the ground floor of residential blocks or along strips beside roads. Sprawling farming settlements with center pivot irrigation systems are located on the periphery of the residential areas, particularly to the north in the more fertile areas.

The land cover within this landscape character type is simple. Where vegetation exists, it is generally associated with residential or commercial property and is intensively maintained. Natural vegetation is sparse and of low quality.

Key Characteristics of this landscape character type, observed during the site visit include:

- Mixed land use, footprint size and density;
- Settled and simple structure; and
- Intensively maintained ornamental vegetation and agriculture. Illustrative views of the feature and character of this LCT are provided in Figure 10-5 to Figure 10-9.

10.3.3.2.1 Sensitivity to Change:

The LCT is defined by the presence of development within it and, to a lesser extent, by the range of types and scales of this development. It is these elements which differentiate this LCT from the adjacent undeveloped desert plain, and desert plateau landscape character types.

A key defining element of the character of this LCT is the robust diversity of scale among the built elements present within it.

No formal designation is placed upon this landscape, nor are there any features which are considered to be unique to this area. In this regard, this landscape character type is considered to be of low susceptibility to change and of low landscape value. As such, this landscape character type is considered to be of low sensitivity in relation to the Park.

Figure 10-5: Typical Settlement within the Settled Desert Plain LCT

Figure 10-6: Industrial Land Use within the Settled Desert Plain LCT (Al Jouf Power Station)

Figure 10-7: Typical Settlement within the Settled Desert Plain LCT (New Worker Accommodation)

Figure 10-8: Farming Settlements within the Settled Desert Plain LCT

Figure 10-9: Centre Pivot Irrigation System within the Settled Desert Plain LCT

10.3.3.3 Desert Plateau LCT

This LCT is located on the high plateau to the north of the study area. The plateau is characterized by a sweeping expanse of rugged, flat, un-vegetated desert landscape interspersed by rocky wadi channels formed during extreme flood events (shown in Figure 10-10 and Figure 10-11). The experience within this LCT is one of open isolation; evidence of human influence is very occasional, limited to a small number of meteorological monitoring stations and completed ground investigation sites.

Land use within this LCT is scattered. There is evidence of nomadic grazing and hunting as well as legacy recreational camping and gardening (shown in Figure 10-12 and Figure 10-13) although this is rare.

Views within this LCT are long range and unobstructed views extend across the plateau to the north and across the adjacent settled desert landscape to the south towards the nearby Al Nafud Desert.

It is within the Desert Plateau LCT that the Park would be sited.

Key Characteristics of this landscape character type, observed during the site visit include:

- Open, expansive desert plateau;
- Vast scale;
- Distinctive wadi channels; and,
- Lack of human influence.

10.3.3.3.1 Sensitivity to Change

This LCT is defined by its elevation, its large scale and the dramatic wadi channels and rock formations, as well as the long range views from the high plateau over nearby settlements which are afforded by the LCTs openness and elevation. Although human activity is rare, communication masts and other infrastructure are visible in most views within the LCT and there are rough tracks throughout.

A key defining element of the character of this LCT is the sensation of ‘emptiness’, defined by the lack of human activity. Although infrastructure is present, it is automated and encounters with, (or visibility of) humans is extremely rare within the LCT.

The vast scale of the LCT defines its capacity for absorbing major infrastructure without fundamental alteration to the landscape experience. No formal designations are placed upon this landscape. In consideration of this, the LCT has been assessed as being of low value and a low sensitivity to change associated with the Park.

Figure 10-10: Desert Plateau LCT

Figure 10-11: Wadi Channel within the Desert Plateau

Figure 10-12: Sparse Human Land Use within the Desert Plateau LCT

Figure 10-13: Legacy Recreational Gardening within the Site

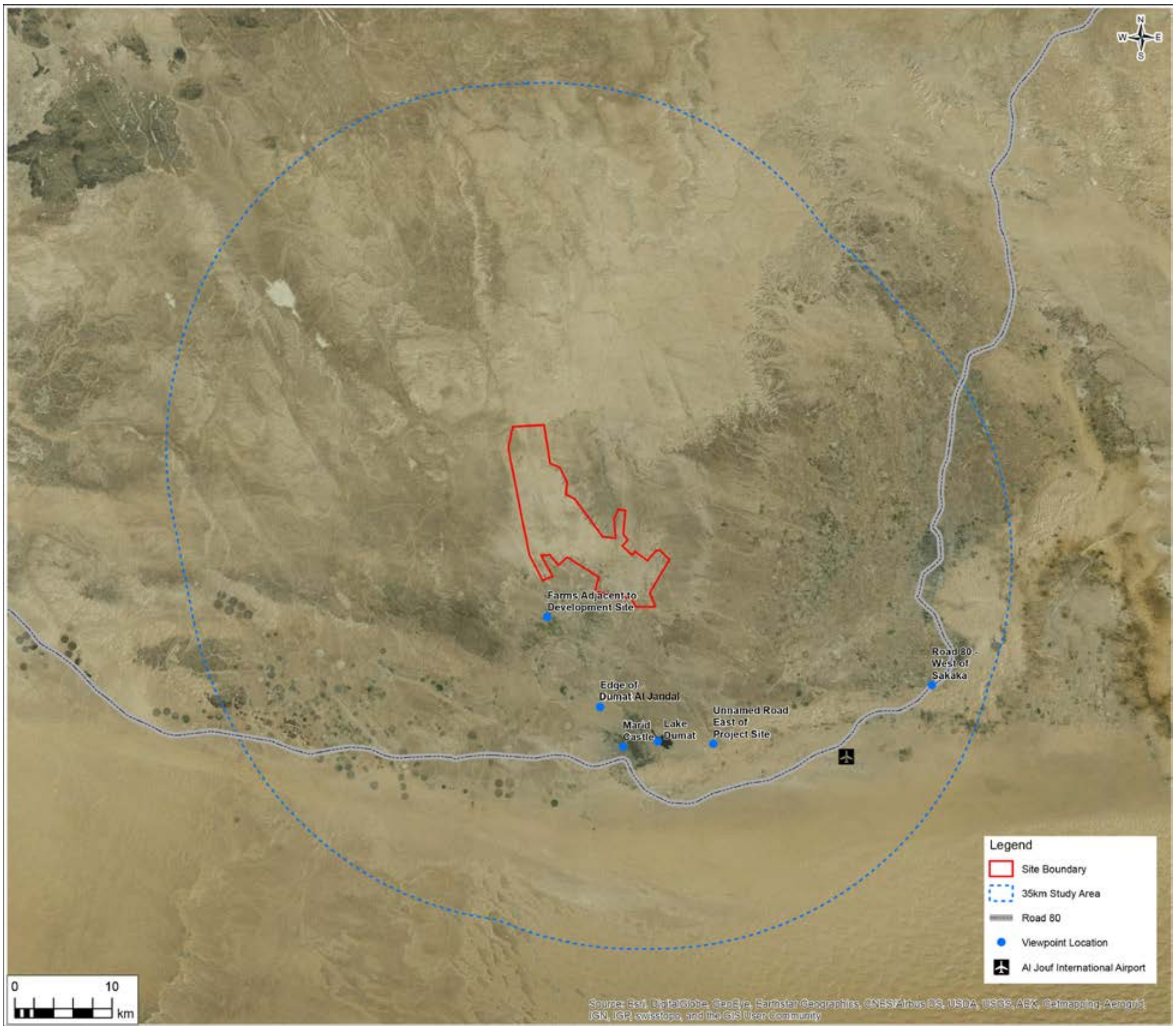

Figure 10-14: Viewpoint Locations

Table 10-1: Viewpoint Locations and Basis for Inclusion

Location	Reason for Inclusion
Farms Adjacent to Development Site	Representative of the view from domestic and arable farms located to the south west of the development site
Edge of Dumat al Jandal	Representative of the view experienced at residential properties on the edge of Dumat al Jandal
Marid Castle	Representative of the view from the culturally significant receptor Marid Castle
Lake Dumat	Representative of the view experienced by recreational users at Lake Dumat

Location	Reason for Inclusion
Unnamed Road East of Project Site	Representative of the view of road users using the unnamed road to the east of the Development Site
Road 80 south west of Sakaka	Representative of the view of road users travelling west out of Sakaka and the Settled Desert Plain LCT

10.4 Assessment Methodology

10.4.1 Baseline Landscape Assessment

The baseline landscape assessment is a description, classification and evaluation of the landscape of the Study Area, from which the potential landscape impacts of the Park can be assessed. This assessment forms the basis against which the magnitude and significance of the predicted landscape and visual impacts arising from the Park are predicted.

The baseline assessment involves three stages:

- Description – the systematic collection and presentation of information about landscape and visual resources;
- Classification – the analytical activity of refining landscape elements into units of distinct and recognizable character; and,
- Evaluation – the process of attributing a value to a given landscape / or visual resource, by reference to specified criteria.

Preliminary visual analysis plans were plotted to inform the early stages of the assessment process.

The process of baseline assessment comprises three main stages, desk study, field survey and analysis. The methods for these three stages are described below.

10.4.1.1 Desk Study

Existing available maps and written data related to the development site and its surrounding 35 km Study Area were reviewed.

The desk study identified the general landscape characteristics of the Study Area and the likely extents of landscape character types. Furthermore, the desk study helped define the likely zone of theoretical visibility of the Park in addition to baseline visual resources such as the key viewpoints and features as well as the likely visual receptors. The location of a range of potential visual receptors was identified, and they were classified according to their associated use (settlements, footpaths, roads etc.). The aim of the baseline assessment of visual resources was to ensure that an appropriate range of viewpoints is included in the visual assessment. These locations were chosen to ensure that the viewpoint assessment included a representative range of the following:

- type of receptor – based on the range outlined above;
- a range of different landscapes and character types;
- viewpoint altitude;

- distance of receptor from Development; and,
- direction of receptor from Development.

The desk study provided the basis for the subsequent field survey work, during which the baseline landscape and visual resources, in addition to potential visual receptors were refined and confirmed.

10.4.1.2 Field Survey

A field walkover survey was carried out by Jacobs Landscape Architects in November 2016. The aim of the survey was as follows:

- To evaluate and confirm the desk based interpretation of landscape character;
- To evaluate and confirm the nature of visual amenity;
- To make an assessment of the view at each sensitive receptor, in order to understand the potential impact of the Park upon it; and,
- To record imagery to support the interpretations of character and view at each receptor.

10.4.1.2.1 Photography

Images were recorded using a full frame digital Single Lens Reflex (SLR) camera. The camera was mounted on a tripod in order to obtain a stable platform for the single frame and panoramic views. The position of the tripod was recorded with a handheld GPS device. In addition to recording the location of the viewpoint, observations such as time of day, weather, cloud cover, and visibility were recorded using a standard landscape survey sheet.

10.4.1.2.2 Zone of Theoretical Visibility

The Zone of Theoretical Visibility (ZTV) has been informed by the field survey in addition to the production of visibility mapping through the use of GIS data and software. It should be noted that due to limitations in the accuracy of the digital elevation data used in the production of the visibility mapping professional interpretation of the results (and the likely visibility at each receptor) has been required. Figure 10-15 shows the Zone of Theoretical Visibility.

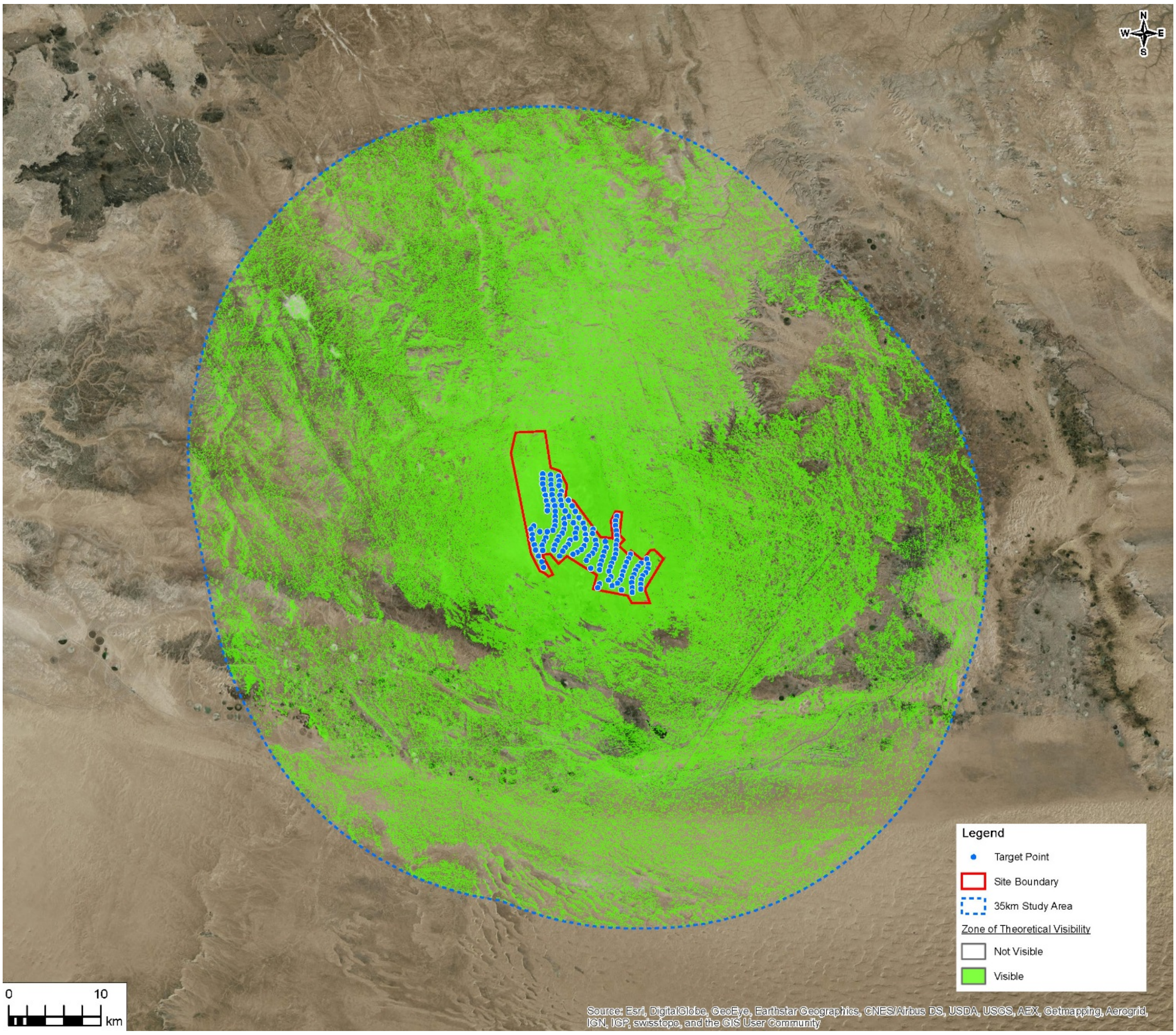

Figure 10-15: Zone of Theoretical Visibility

10.4.1.3 Analysis and Reporting

Analysis and reporting of the baseline assessment took place following the completion of the desk and field surveys. The findings of the baseline assessment are reported in Section 10.3.

10.4.2 Assessment of Residual Landscape and Visual Impacts

The aim of an environmental assessment is to identify, predict and evaluate potential key impacts arising from a proposed development. Wherever possible, identified impacts are quantified. However, the nature of LVIA requires an element of interpretation using professional judgement. In order to provide a level of consistency to the assessment, the prediction of magnitude and assessment of significance of the residual landscape and visual impacts have been based on pre-defined criteria, as discussed below.

10.4.3 Landscape Impacts

Landscape impacts can be defined as the changes to the physical form, structure and fabric of a landscape. Different types of landscape are typically identified as ‘character types’ which are defined areas, categorized by similarities in form, structure and fabric.

Landscape impacts are assessed with regard to the sensitivity of the landscape (derived from its susceptibility to change and value), and the magnitude of change expected to be experienced.

The following sections set out the methodology specific to the type of impact being considered, and describe how the sensitivity and the magnitude of change ('nature of the impact', considering size/scale/extent, duration and reversibility) on each receptor were identified, and used to judge the significance of impact.

The scale and geographical extent of landscape impacts are measures of the extent of existing landscape elements that would be lost, the proportion of the resource that this represents, the contribution of such elements to the character of the landscape, and the size of the geographical area across which the impacts would be felt. In terms of landscape character, this reflects the degree to which the character of the landscape would change by removal or addition of landscape components, and how the changes would affect key characteristics.

10.4.3.1 Assessing Landscape Sensitivity

The sensitivity of the landscape is not absolute and varies according to the existing landscape, the nature of the proposed development and the type of change being considered. The determination of the sensitivity of the landscape resource to changes associated with the proposed development is defined as high, medium, low or negligible – or intermediate bands between these. It is developed from guidance within GLVIA 3, and based on professional interpretation of a combination of parameters as follows:

- Key landscape characteristics – a professional evaluation based on the key characteristics of the landscape and existing landscape character assessments describing the elements that make up the landscape including:
  - Physical influences – geology, soils, landform, drainage and water bodies;
  - Land cover, including different types of vegetation and patterns and types of tree cover;
  - The influence of human activity, including land use and management, the character of settlements and buildings, and pattern and types of fields and enclosure;
- The aesthetic and perceptual aspects of the landscape – such as its scale, complexity, openness, tranquility or wildness; and,
- The nature of views – whether open, closed, long or short distance, simple or diverse.

GLVIA 3 advises that the two components of landscape value and susceptibility to change are taken into account in assigning sensitivity to change from the proposed development to landscape and visual receptors. The two factors are described and explained in greater detail below.

10.4.3.1.1 Value Attached to Landscape

Establishing landscape value forms part of establishing the baseline description. Understanding how society values different landscapes informs judgements in the assessment phase about significance of impacts. Value is most often expressed through designation – as reflected by local, regional or national landscape designation; however, undesignated landscapes and components of individual landscapes also need to be considered. As part of the baseline the following factors are considered when developing an understanding of landscape value:

- landscape quality / condition – the physical state of the landscape;
- scenic quality – aspects of the landscape that appeal to the senses;
- rarity – presence of unusual or rare features;
- representativeness – the landscape may be representative of a typical landscape;
- conservation interests – wildlife, earth science or archaeological importance;
- recreation values –particularly where landscape experience is important;
- perceptual aspects – value for particular experience such as tranquility or wildness; and,
- cultural associations – with people such as writers or artists, events such as battles, etc.

Information on landscape value is included in the baseline descriptions of landscape character/ landscape receptor, described in the process of setting out baseline landscape designations, and added to where appropriate through additional baseline reporting.

10.4.3.1.2 Susceptibility to Change

GLVIA 3 defines susceptibility to change as *"the ability of the landscape…to accommodate the proposed development without undue consequences for the maintenance of the baseline situation and/or the achievement of landscape planning policies and strategies."*

The degree to which a particular landscape type or area can accommodate change will vary with:

- existing land use;
- the pattern and scale of the landscape;
- visual enclosure / openness of views, and distribution of visual receptors; and,
- the scope for mitigation, which will be in character with the existing landscape

Key characteristics likely to be affected by the development are evaluated, taking into account *"quality, value, contribution to landscape character, and the degree to which the particular element or characteristic can be replaced or substituted".*

In order to evaluate the sensitivity of the landscape / landscape receptor, the criteria outlined in Table 10-2 have been used, combining an understanding of the landscape value and susceptibility to change based on GLVIA 3.

Table 10-2: Definition of Landscape Sensitivity

Description	Sensitivity
Landscape with important components, usually of particularly distinctive character and high quality, susceptible to relatively small changes and for which mitigation will be difficult or not possible. Some less distinctive or lower quality landscapes may also fall into this category where characteristics are such that mitigation of negative changes will be difficult. Landscape is often recognized through	High Sensitivity

Description	Sensitivity
designation at international / national / regional level.	
Landscape with characteristics reasonably tolerant of changes or for which mitigation is likely to be possible. These landscapes may be of high quality or of distinctive character but will usually be relatively ordinary and moderately valued.	Medium Sensitivity
A less distinctive or relatively poor landscape with few features of quality or interest, potentially tolerant of substantial change and with scope for mitigation of any negative changes.	Low Sensitivity
Considerably degraded landscape, with few / no features of quality or interest, e.g. heavily industrialized landscapes	Negligible Sensitivity

In some instances a landscape with important components and high quality may be of a lower sensitivity as a result of its potential tolerance to change and opportunities for mitigation, e.g. a variable landform or high levels of tree cover. Conversely a landscape with few features of interest may be of a higher sensitivity because it is vulnerable to change, e.g. a flat landscape with an open character providing little opportunity to mitigate against adverse change.

Having described the landscape resource and the key components that contribute to the character of the landscape type, and having categorized the sensitivity of each landscape type or landscape receptor to change, the probable magnitude of change that would be sustained as a result of the proposed development is then assessed. This change could be adverse, neutral or beneficial. The assessment of the magnitude of change is described below.

10.4.3.2 Magnitude of Change on Landscape/Landscape Receptors

Each impact on landscape/landscape receptors needs to be assessed in terms of its size or scale, the geographical extent of the area influenced, and its duration and reversibility, i.e. its magnitude of change. The scale and geographical extent of landscape impacts are measures of the extent of existing landscape elements that would be lost, the proportion of the resource that this represents, the contribution of such elements to the character of the landscape, and the size of the geographical area across which the impacts would be felt. In terms of landscape character, this reflects the degree to which the character of the landscape would change by removal or addition of landscape components, and how the changes would affect key characteristics.

Judgements are made about the size or scale of the change in the landscape that are likely to be experienced as a result of the Park. The judgements take account of:

- the extent to which landscape elements will be lost, the proportion of the total extent that this represents and the contribution of that element to the character of the landscape;
- the degree to which aesthetic or perceptual aspects of the landscape are altered either by removal of existing components of the landscape or by addition of new ones; and
- whether the impact changes the key characteristics of the landscape, which are critical to its distinctive character.

10.4.3.2.1 Geographical Extent (of influence within the Landscape Character Area/Type)

The geographical extent over which landscape impacts occur will be considered. Distinct from size or scale, the extent of impacts will vary according to the nature of the proposal. The impact of a development may have an influence at the following scales:

- at site level, within the development site itself;
- at the level of the immediate setting of the site;
- at the scale of the landscape type or character area within which the proposal lies; or,
- at a larger scale influencing several landscape types or character areas.

10.4.3.2.2 Duration and Reversibility of Landscape Impacts

The impacts on the landscape will continue for the permitted life of the Park.

10.4.3.2.3 Judgement on Magnitude of Change

Magnitude of change on landscape/landscape receptors is categorized as major, moderate, slight, or negligible – or intermediate categories – as set out in Table 10-3. There may also be no magnitude of change, where further analysis of potential impacts upon landscape receptors reveals that there will be no alteration as a result of the Park.

Table 10-3: Definition of Magnitude

Level of Magnitude	Definition of Magnitude
Substantial	Total loss or major alteration to key elements / features / characteristics of the baseline (pre-development) conditions, such that post-development character / composition of baseline will be fundamentally changed.
Moderate	Partial loss or alteration to one or more key elements / features / characteristics of the baseline (pre-development) conditions, such that post-development character / composition / attributes of baseline will be partially changed.
Slight	Minor loss of or alteration to one or more key elements / features / characteristics of the baseline (pre-development) conditions. Change arising from the loss / alteration will be discernible, but underlying character / composition of the baseline condition will be similar to pre-development circumstances / patterns.
Negligible	Very minor loss or alteration to one or more key elements / features / characteristics of the baseline (pre-development) conditions. Change barely distinguishable, approximating to the ‘no change’ situation.

10.4.3.3 Visual Receptor Sensitivity

The sensitivity of visual receptors depends upon:

- the location of the viewpoint, and its position relative to the Park;
- the context of the view;
- the activity of the receptor at the viewpoint location; and,
- frequency and duration of the view.

10.4.3.3.1 Value attached to Views

Judgements are also made about the value attached to views experienced taking account of:

- Recognition of the value attached to particular views, for example in relation to heritage assets, or through planning designations.
- Indication of value attached to particular locations as a distinctive view through appearance in guide books, provision of formal facilities such as a car park and sign board, references in art and literature.

10.4.3.3.2 Susceptibility of Visual Receptors to Change

The susceptibility of different visual receptors to changes in views is a function of:

- the occupation or activity of people experiencing the view at particular locations; and
- the extent to which their attention or interest may therefore be focused on the views and visual amenity they experience at particular locations.

Visual receptor susceptibility is defined as high, medium, low or negligible, or bands in-between, as set out in

Table 10-4: Definition of Visual Receptor Susceptibility

Visual Receptor Susceptibility	Definition
High	Users of outdoor recreational facilities including strategic recreational footpaths, promoted cycle routes or rights of way, whose attention may be focused on the landscape; important landscape features with physical, cultural or historic attributes; views from principal settlements; visitors to scenic areas and picnic areas.
Medium	Other footpaths; people travelling through or past the landscape on most roads, train lines or other transport routes, views from minor settlements.
Low	People engaged in outdoor sports or recreation (other than appreciation of the landscape); those whose attention may be focused on their work or activity rather than the wider landscape; travelers on highways.
Negligible	Views from heavily industrialized areas.

10.4.3.4 Magnitude of Change on Visual Receptors

The magnitude of visual change arising from the Park is described as substantial, moderate, slight, or negligible based on size or scale, the overall geographical extent of visibility, and the duration and reversibility. It may also be the case that analysis reveals that there will be no change. For individual viewpoints it will depend upon:

- distance of the viewpoint from the proposed development;
- duration of impact;
- angle of view in relation to main receptor activity;
- proportion of the field of view occupied by the proposed development;
- background to the proposed development, and;
- extent of other built development visible, particularly vertical elements.

10.4.3.4.1 Size or Scale

Judging magnitude of visual impacts identified needs to take account of:

- the scale of change in the view with respect to the loss or addition of features in the view and changes in its composition, including the proportion of the view occupied by the proposed development;
- the degree of contrast or integration of any new features or changes in the landscape with the existing or remaining landscape elements and characteristics in terms of form, scale and mass, line, height, color and texture, and;
- the nature of the proposed development, in terms of the relative amount of time over which it will be experienced and whether views will be full, partial or glimpses.

10.4.3.4.2 Geographical Extent

The geographical extent of a visual impact will vary with different viewpoints and is likely to reflect:

- the angle of the view in relation to the main activity of the receptor;
- the distance of the viewpoint from the proposed development, and;
- the extent of the area over which the changes would be visible.

10.4.3.4.3 Duration and Reversibility of Visual Impacts

The impact on views will continue for the permitted life of the Park. All impacts are reversible following decommissioning of the Park.

10.4.4 Level and Significance of Impacts

Overall significance of each impact is assessed according to the magnitude of the impact and the sensitivity of the receptor, with regard to the criteria shown in Chapter 5 – Impact Assessment Methodology. All impacts are adverse unless otherwise stated.

10.5 Impact Assessment

10.5.1 Construction Phase

10.5.1.1 Landscape Impacts

The sensitivity to change of the landscape within the development site has been assessed as low. Table 10-5 provides the assessment of impacts upon the landscape expected to arise as a result of the Park during the construction phase.

Table 10-5: Construction Phase Landscape Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
LA01	Desert Plain LCT	Low	Alteration of landscape during construction phase due to construction of access tracks and the Park	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Infrequent Short Local Reversible	Low	Low
LA02	Development site (Desert Plateau LCT)	Low	Alteration of landscape during construction phase due to construction of access tracks and the Park	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Infrequent Short Local Reversible	Low	Low
LA03	Settled Desert Plain LCT	Low	Alteration of landscape during construction phase due to construction of access tracks and the Park	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Infrequent Short Local Reversible	Low	Low

10.5.1.2 Alteration of Landscape (Desert Plain LCT)

No direct impacts upon the Desert Plain LCT are anticipated as a result of the Park. The Dumat Al Jandal Wind Energy Park would be constructed in the nearby LCT and no associated infrastructure would be present within the Desert Plain LCT. The ZTV shows that the Park would be visible at long range views of over 20 km in views from this LCT, this is not considered sufficiently significant to impact upon the character of this LCT which is distinct from the Desert Plateau LCT.

10.5.1.3 Alteration of Landscape (Desert Plateau LCT)

The introduction of vehicle access tracks and the construction of the Park would result in a localized change in the character of the landscape within the site boundary. This change would largely be attributable to the erection of the turbines which would introduce large-scale vertical features into the landscape and would create a 'Desert Plateau with Wind Turbines' landscape character sub-type. While the change would be significant locally, in terms of the change to the Desert Plateau LCT as a whole, (which is a common landscape type throughout the Kingdom of Saudi Arabia) the overall impact on this LCT would be limited.

It should be noted that, the element of highest landscape value within this otherwise unremarkable LCT, are the intricate wadi channels which form an element of interest within the fabric of the landscape. Due to the requirement of the turbines to be located outside the wadi channels in order to reduce flood risk, the design of the Park has avoided direct impacts on these features.

The experience of being within this LCT is of quiet tranquility and remoteness, the LCT is not devoid of human influence, but due to the open and long range views in all directions, the sense of isolation is exacerbated. During construction, additional human activity would be introduced into the LCT which would alter the sense of remote isolation. However, this impact would be largely limited to the construction phase alone.

10.5.1.4 Alteration of Landscape (Settled Desert Plain LCT)

No impact upon the Settled Desert Plain LCT is anticipated. The Dumat Al Jandal Wind Energy Park would be constructed in the adjacent LCT and no associated infrastructure would be present within the Settled Desert Plain LCT. The ZTV shows that the Park would be intermittently visible at long range (of over 15 km) in views from this LCT; this is not considered sufficiently significant to impact upon the character of this LCT which is distinct from the Desert Plateau LCT.

10.5.1.5 Visual Impacts

The impact upon specific visual receptors has been assessed within the operational phase impact assessment. It is not anticipated that construction or decommissioning impacts would differ significantly from operational impacts in this regard albeit there would be the temporary presence of cranes and construction vehicles.

10.5.2 Operation Phase

The following section provides an assessment of impacts on LCTs during the operational phase of the Park.

10.5.2.1 Landscape Impacts

Table 10-6 shows predicted operational phase landscape impacts.

Table 10-6: Operation Phase Landscape Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
LA04	Desert Plain LCT	Low	No direct impact Perceived indirect impact associated with the alteration of landscape character as a result of the Dumat Al Jandal Wind Energy Park in the adjacent landscape character type	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Indirect Certain Infrequent Medium Local Reversible	Low	Low
LA05	Desert Plateau LCT	Low	Direct impact associated with the alteration of landscape character due to the introduction of Dumat Al Jandal Wind Energy Park	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Medium Local Reversible	Moderate	Moderate

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
LA06	Settled Desert Plain LCT	Low	No direct impact Perceived indirect impact associated with the alteration of landscape character as a result of the Dumat Al Jandal Wind Energy Park in the adjacent landscape character type	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Indirect Certain Infrequent Medium Local Reversible	Low	Low

10.5.2.2 Alteration of Landscape (Desert Plain LCT)

There would be no direct impacts on the defining characteristics of the Desert Plain LCT as a result of the introduction of the Park into the nearby LCT.

Impact LA04 - Low Significance

10.5.2.3 Alteration of Landscape (Desert Plateau LCT)

Following construction of the Park, its presence and operation within the Desert Plateau LCT would continue to constitute an 'Desert Plateau with Wind Turbines' landscape character sub-type. This sub-type would endure for the lifetime of the Park until decommissioning. The experience of being within this LCT is of quiet tranquility and remoteness, the LCT is not devoid of human influence, but due to the open and long range views in all directions, and the vast scale the sense of isolation is exacerbated. While the Park would constitute a change within the development site, its presence would not fundamentally alter the experiential qualities of the wider LCT (particularly given its vast scale – beyond the study area).

Following decommissioning of the Park, the intention is for the turbines and associated infrastructure to be fully removed, and the land returned to its pre development condition. In this regard, the impact associated with the development of the Park can be considered to be temporary.

While there would be a change within the development site, the overall magnitude of change experienced within this LCT is assessed as being low. This is due to the vast scale of the LCT which can accommodate the scale of the Park without significant change to its integrity, and the temporal nature of the impact. The significance of this impact is assessed as low.

Impact LA05 - Low Significance

10.5.2.4 Alteration of Landscape (Settled Desert Plain LCT)

There would be no direct impacts on the defining characteristics of the Settled Desert Plain LCT as a result of the introduction of the Park into the adjacent LCT.

Impact LA06 - Low Significance

10.5.2.5 Visual Impacts

The following section provides an assessment of the impacts resulting from the Park on the visual amenity of nearby receptors (such as road users and residents). It should be noted that during the summer months, when the temperature is higher, views will be affected by the presence of heat haze across the horizon which effectively limits longer distance views across the desert landscape towards the development site. Similarly, during periods of moderate to high wind, dust will potentially obscure views, particularly over the medium to long range. Chapter 06 *Meteorology and Air Quality* assesses the impact of dust in detail.

Table 10-7: Operational Phase Visual Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
LA07	Farms Adjacent to Development Site	Moderate	Alteration of the view from the receptor. Introduction of Dumat Al Jandal Wind Energy Park within landscape	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Medium Local Reversible	Moderate	Moderate
LA08	Edge of Dumat al Jandal	Low	Alteration of the view from the receptor. Introduction of Dumat Al Jandal Wind Energy Park within landscape	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Indirect Certain Continuous Medium Local Reversible	Low	Low
LA09	Marid Castle	High	Alteration of the view from the receptor. Introduction of Dumat Al Jandal Wind Energy Park within landscape	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Medium Local Reversible	Moderate	High
LA10	Unnamed Road East of Development Site	Moderate	Alteration of the view from the receptor Introduction of Dumat Al Jandal Wind Energy Park within landscape	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Continuous Medium Local Reversible	Low	Low
LA11	Lake Dumat	Low	Alteration of the view from the receptor Introduction of Dumat Al Jandal Wind Energy Park within landscape	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Continuous Medium Local Reversible	Low	Low
LA12	Road 80, West of Sakaka	Moderate	Alteration of the view from the receptor Introduction of Dumat Al Jandal Wind Energy Park within landscape	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Continuous Medium Local Reversible	Low	Low

10.5.2.6 Alteration of view (Receptor: Farms Adjacent to Development Site)

This viewpoint is representative of the view experienced by workers and residents at the farm located to the west of the development site.

For the purposes of this assessment, receptors are assessed as Moderate sensitivity due to the fact that these are minor settlements. Although these are residential receptors, the majority of the land is occupied by farm buildings and the focus of those within the landscape is on this activity rather than enjoyment of the landscape itself. Furthermore the perimeter of each plot is almost entirely bounded by tall trees, which obscure views from residential buildings within them. These are shown in Figure 10-17. It is not clear at this stage the extent to which these plots are used for residential purposes, if at all. However, for the purposes of conservative assessment, it has been assumed that they are.

Existing views from this location towards the development site comprise rough desert, scattered farming settlements and occasional clumps of trees surrounding properties.

The value of the view from this location is considered to be low, due to the lack of any unique or defining characteristics and the large amount of human influence. The overall experience of this area of the landscape is one of rough utilitarianism. Little attention has been paid to the aesthetic qualities of the landscape, with preference being given to purely functional usage.

Figure 10-16 shows a wireframe view of the Park from this location. The majority of the Park would be visible above the plateau on the horizon, in views north from these locations at short range, of approximately 3km to the nearest turbine. Although screening does exist at the boundaries of properties, the magnitude of change experienced at views outside these boundaries is assessed as moderate.

The view from these locations is of a wide and large scale, open plateau, and is unremarkable. Despite this, due to the fact that the majority of the Park would be visible in these views, and in the interest of conservative assessment, the magnitude of change is assessed as moderate, and the impact has therefore been assessed as moderate significance.

Impact LA05 -Moderate Significance

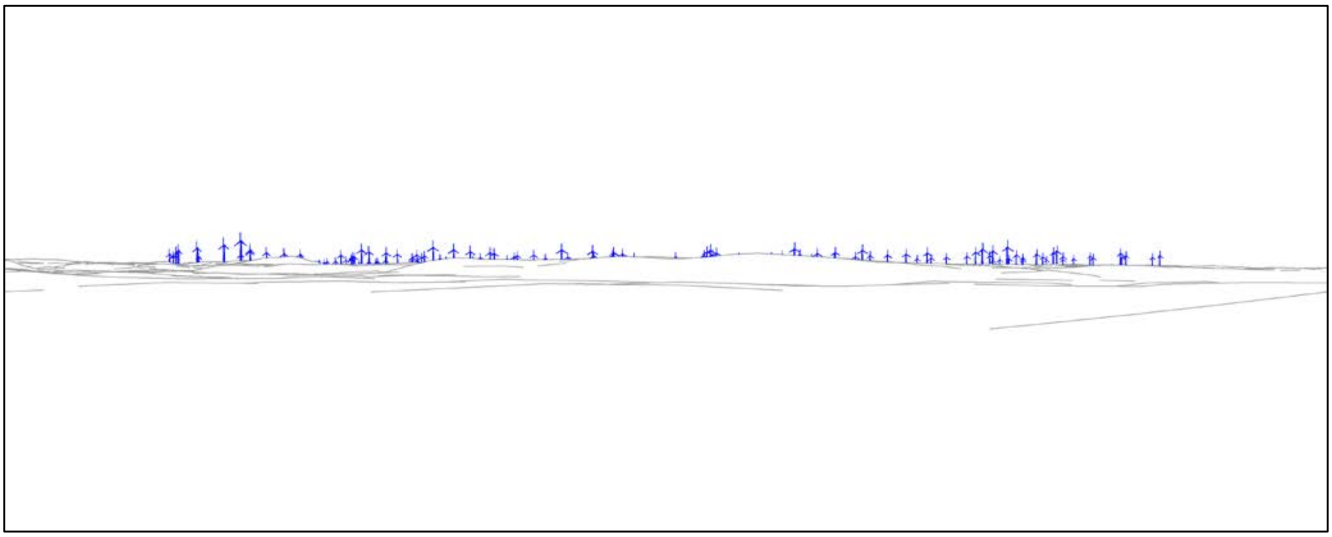

Figure 10-16: View from Farms West of the Development Site

Figure 10-17: Trees at Boundary of Farms

10.5.2.7 Alteration of view (Receptor: Edge of Dumat Al Jandal)

This viewpoint is representative of the view experienced by residents and road users at the northern edge of the settlement of Dumat Al Jandal.

For the purposes of this assessment, receptors at this location are assessed as being high/medium sensitivity due to the fact that these scattered houses on the edge of Dumat Al Jandal are considered minor settlements.

The view towards the development site from this location is unremarkable, looking across open rocky desert and existing scattered infrastructure such as electricity transmission pylons, mobile communication towers and a water tower.

The value of the view from this location is considered to be low due to the high amount of human infrastructure present within it, the lack of any distinct or defining characteristics and the low quality of the landscape within it. Although more treated landscapes exist to the south of this location, within the town of Dumat Al Jandal, the view towards the Park consists solely of rough desert and is focused on utility rather than aesthetic.

The introduction of the Dumat Al Jandal Wind Energy Park into this view would represent a minor change in the view, the blade tips of turbines would be visible above the horizon. Despite the change to the view, it is not considered that this would represent a significant impact, as the view already contains significant amounts of infrastructure at a much closer range than that which the Park would be viewed at.

Figure 10-18 shows a wireframe representation of the predicted view from this location.

Due to the low quality of the view and the fact that the majority of the Park would be screened from view, despite the high/medium sensitivity of the receptor, the magnitude of change would be low and the resulting impact of low significance.

Impact LA06 - Low Significance

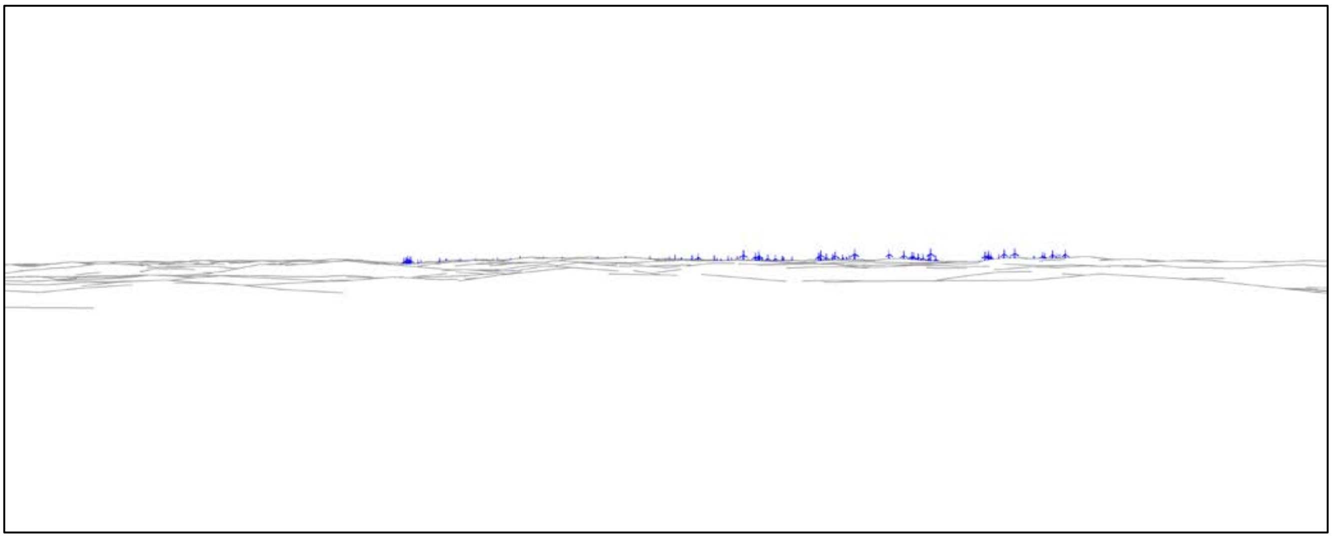

Figure 10-18: View from Edge of Dumat Al Jandal towards the Development Site

10.5.2.8 Alteration of view (Receptor: Marid Castle)

This viewpoint is representative of the view experienced by visitors to the historically significant Marid Castle located in Dumat Al Jandal.

For the purposes of this assessment, receptors at this location are considered of high sensitivity due to the classification as '*important landscape features with physical, cultural or historic attributes'*.

Views from this location are open, panoramic and long range, with viewers often able to experience 360 degree views of the surrounding landscape. The Park would be visible in a prominent location on the horizon in views north of this location, at a distance of approximately 15km to the nearest turbine.

The value of the view from this location is considered moderate due to the fact that receptors are able to view the entire horizon in all directions. However, the capacity of this view to absorb change is high due to its very large scale.

Figure 10-19 shows a wireframe representation of the view from this location and Figure 10-20 shows an illustrative representation of the same view. The majority of the Park would be visible within this view.

Although there would be some reduction in the change through the presence of heat haze and dust, during cooler periods, or when particulate matter levels are low, the Park will be fully visible in views from this location. Furthermore, when the sun is at an oblique angle to the Park, the reflection of sunlight from the turbines would further highlight their presence within the landscape.

Due to the open and large scale of the views from this location, and the sensitive nature of the view, the significance of this impact is assessed as high.

Impact LA07 – High Significance

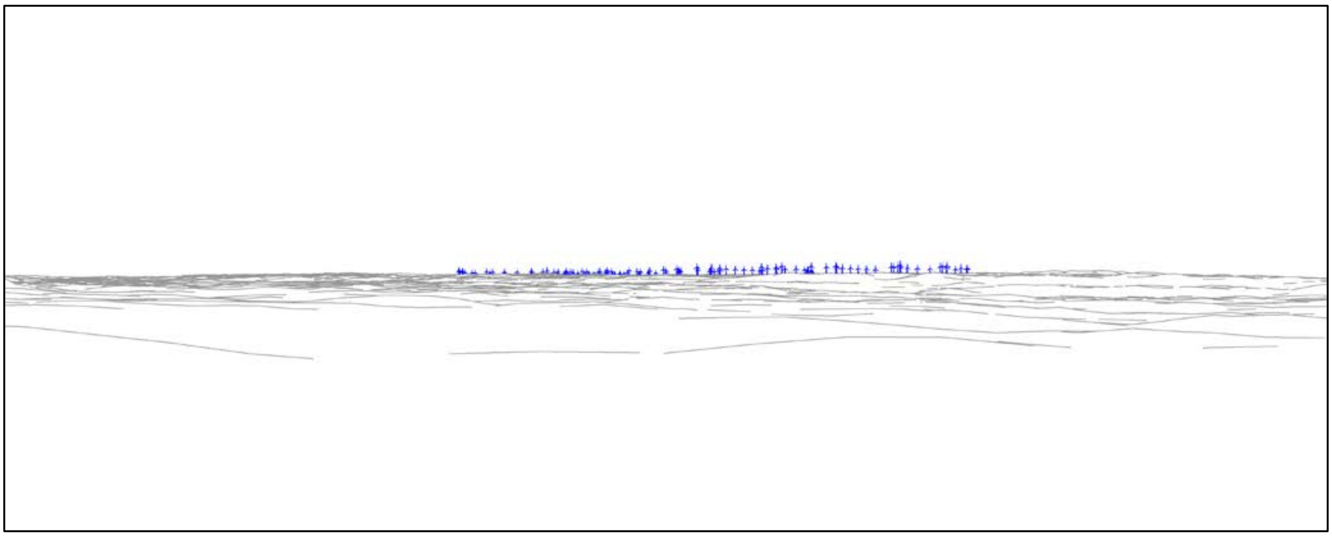

Figure 10-19: View from Marid Castle towards the Development Site

Figure 10-20: View from Marid Castle

10.5.2.9 Alteration of view (Receptor: Unnamed Road East of Development Site)

This viewpoint is representative of the view experienced at the scattered settlements to the east of the development site.

For the purposes of this assessment, receptors at this location are assessed as being medium sensitivity due to the classification of scattered settlements as minor settlements.

Figure 10-21 shows a wireframe representation of view from this location. Views towards the Park from this location are long range at a distance of approximately 17km to the nearest turbine and screened by the undulating landform present in this section of the study area. The value of the view from this location is considered to be low, due to the lack of defining or unique characteristics within it.

Despite the medium sensitivity of the receptors at this location, the significance of the impact is reduced by the long range and intermittent nature of the views, and the fact that the majority of views are enclosed and screened by the short range landform, the magnitude of change at this location is assessed as being of low, and the resulting impact of low significance.

Impact LA08 - Low significance

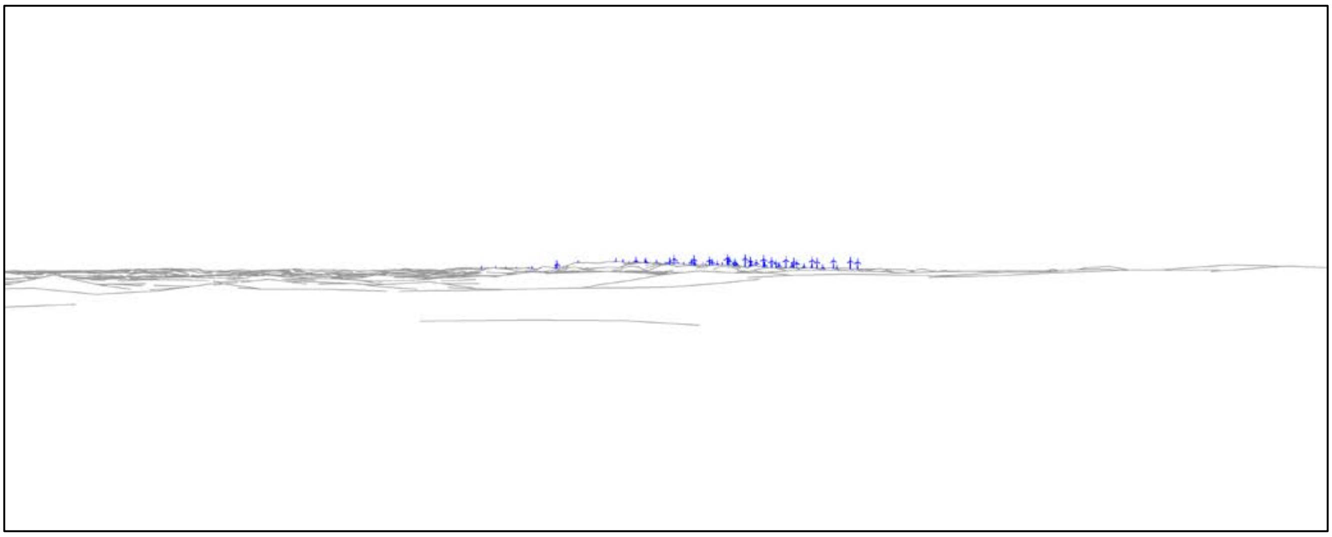

Figure 10-21: Wireframe View from Unnamed Road towards the Development Site

10.5.2.10 Alteration of view (Receptor: Lake Dumat)

This viewpoint is representative of the view experienced by users of Lake Dumat; this is limited exclusively to recreational users and a small amount of workers.

For the purposes of this assessment, receptors at this location are assessed as low sensitivity, being those *engaged in outdoor sports or recreation (other than appreciation of the landscape);*

Views from this location are enclosed by the banks of the lake. The majority of recreational facilities are located at a lower elevation than the ridge line, which allows it to provide a significant amount of screening to long range views. It is likely that blade tips of some turbines would be partially visible above the horizon line from this location. The value of views within this location is assessed as being moderate.

Figure 10-22 shows a wireframe representation of the view from this location. Figure 10-23 shows an illustrative photograph of the view from the lake. It is noted that this photograph does not represent the view towards the Park.

Due to the fact that views out of the location are not the primary focus of recreation at this location, and the small change anticipated to this view. The magnitude of change experienced at this location is assessed as low, and the resulting impact, of low significance.

Impact LA09 - Low significance

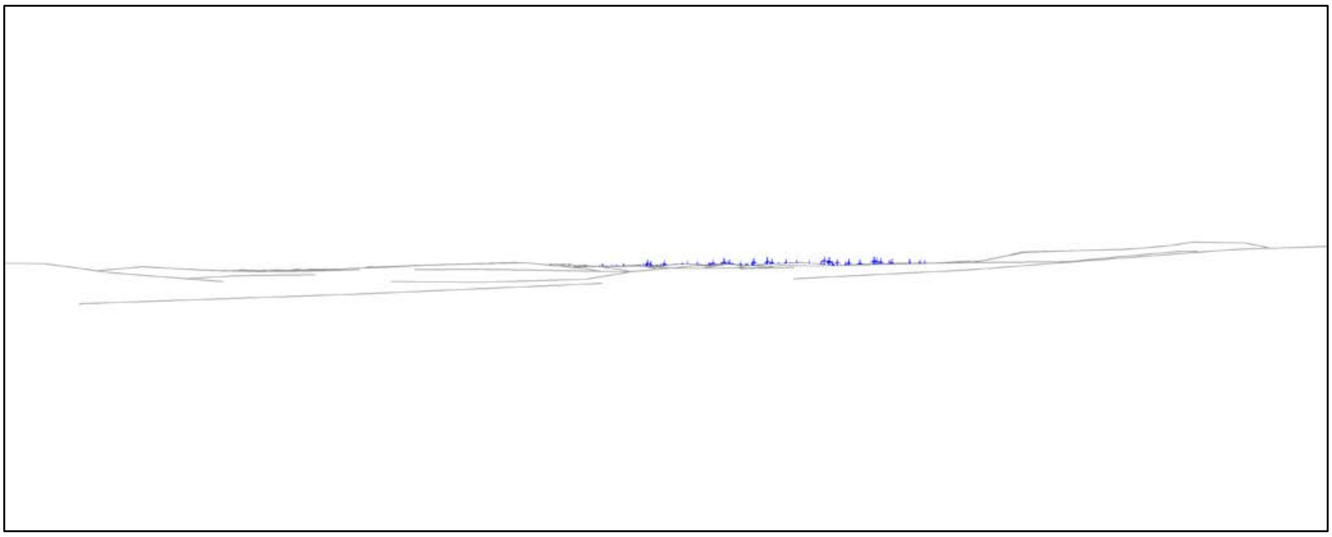

Figure 10-22: Wireframe View from Lake Dumat

Figure 10-23: Illustrative view of Lake Dumat

10.5.2.11 Alteration of view (Receptor: Road 80, west of Sakaka)

This viewpoint is representative of the view experienced by receptors driving westbound along Road 80, leaving Sakaka and those occupying commercial and residential properties on the south west periphery of Sakaka.

For the purposes of this assessment, receptors at this location are assessed as being medium sensitivity due to the classification of the scattered houses as minor settlements.

Figure 10-24 shows a wireframe representation of the predicted view from this location and Figure 10-25 shows an illustrative representation of the same view. The view is long range at approximately 30km to the nearest turbine, across the Settled Desert Plain LCT. The blade tips of turbines would be partially visible on the horizon, and will be screened intermittently by the presence of vegetation and infrastructure within the Settled Desert Plain LCT.

Views are assessed as being of low value from this location due to the lack of any defining or unique features within them.

Due to the intermittent and long range nature of views from this location, and the medium sensitivity of the receptors, the magnitude of change experienced at this location and the resulting impact are assessed as being of low significance.

Impact LA09 – Low Significance

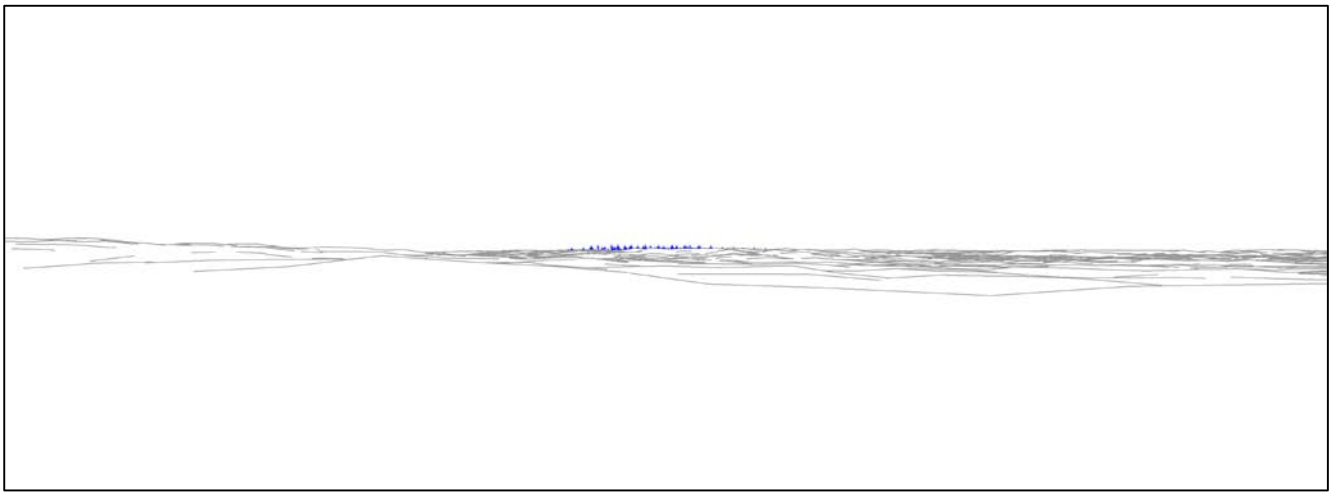

Figure 10-24: View from Road 80, West of Sakaka

Figure 10-25: View from Road 80 West of Sakaka

10.6 Mitigation

Standard, embedded mitigation measures to reduce landscape and visual impacts would be adopted in order to minimize impacts on landscape and visual receptors. These would include all of the turbines having the same rotor diameter of up to 140 meters and hub height not exceeding 155 meters and turning in the same direction at broadly the same speed. The turbines would be of a traditional three bladed horizontal axis design with tubular steel towers and nacelles. Research (Stevenson and Griffiths, 1995) has confirmed that tubular steel towers reduce visual clutter and are preferred to lattice or pylon-like generator towers. Turbine transformers, in line with larger turbine designs, would normally be mounted within the machines to reduce visual clutter. If the transformers are external to the turbines, then an appropriate color which diminishes their visual impact should be adopted. In relation to the characteristics of the site and surrounding landscape, a sand color or light brown would be most appropriate. The turbines would all be a similar color and finish so as to promote visual integration.

10.7 Conclusion

In conclusion, an assessment of the likely impacts on landscape and visual receptors within a 35 km radius of the development site of the proposed Dumat Al Jandal Wind Energy Park has been undertaken as part of the Landscape and Visual Impact Assessment. This LVIA has been undertaken in accordance with GLVIA 3 (prepared by the United Kingdom's Landscape Institute) and followed a stage approach including identification of the baseline environmental conditional and impact assessment. The assessment found that there would be no significant impacts on the desert landscape character types identified within the Study Area, and that there would be no significant impacts on visual receptors within the Study Area. The impact identified at Marid Castle, although of a precautionary high significance, would be experienced only under certain conditions.

10.8 References

Guidelines for Landscape and Visual Impact Assessment (3rd Edition) – Landscape Institute and the Institute of Environmental Assessment and Management (2013);

Landscape Character Assessment, Guidance for England and Scotland - The Countryside Agency and Scottish Natural Heritage (2002); and

Photography and Photomontage in Landscape and Visual Impact Assessment - The Landscape Institute, Advice Note 01/11 (March 2011).

Environmental, Health, and Safety Guidelines for Wind Energy – World Bank Group (August 2015)

11. Terrestrial Biodiversity

11.1 Overview

This chapter aims to determine the terrestrial biodiversity resources within the development site and the wider region through desk-top review of available resources and literature. This baseline review has been used to inform the design and approach to targeted baseline surveys for terrestrial biodiversity resources.

With respect to ornithology, the desk-top study aims to determine the level and importance of bird migration in the vicinity of the Dumat Al Jandal Wind Energy Park and will be utilized to inform our baseline approach. To achieve this, designated and known bottleneck sites on the associated East Asian/East African Flyway have been assessed along with related literature in an attempt to identify key species, peak migration periods and defined routes of migration in the region. Important Bird and Biodiversity Areas (IBAs) as identified by BirdLife International are discussed separately and these are a key source of information in the region.

The impact assessment is supported by a baseline ornithology survey report which is included within Appendix F. This report provides the findings of a desk-top study, describes the baseline ornithology survey designs, the results of all baseline surveys, and the results of Collision Risk Modelling.

11.2 International and National Standards and Guidance

11.2.1 International Conventions

11.2.1.1 Convention on Biological Diversity

Saudi Arabia ratified the Convention on Biological Diversity in 2001. The Convention on Biological Diversity is "*dedicated to promoting sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality, the Convention recognizes that biological diversity is about more than plants, animals and micro-organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live*" (www.cbd.int/convention). As a party to the Convention, the Kingdom of Saudi Arabia has to report on the progress of its obligations under the Convention.

11.2.1.2 Convention on the Conservation of Migratory Species of Wild Animals

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) is an environmental treaty implemented under the United Nations Environment Program (UNEP). It provides a global platform for the conservation and sustainable use of migratory animals and their habitats. The Convention brings together brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range (www.cms.int).

Migratory species threatened with extinction are listed on Appendix I of the Convention. CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them. Besides establishing obligations for each State joining the Convention, CMS promotes concerted action among the Range States of many of these species (www.cms.int).

Migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention. For this reason, the Convention encourages the Range States to conclude global or regional agreements (www.cms.int).

Saudi Arabia is a party to the Convention, ratified in 1991. As a party to the Convention, the Kingdom of Saudi Arabia has to report on the progress of its obligations under the Convention.

11.2.2 Regional Conventions

11.2.2.1 Convention on the Conservation of Wildlife and their Natural Habitats in the Countries of the Gulf Cooperation Council (GCC)

The Convention is the first legal instrument binding the six member States of the Gulf Cooperation Council (GCC) to coordinate their activities toward the conservation of wildlife and natural habitats. This Convention, which was signed on 30 December 2001 in Muscat, came into force in April 2003. The Convention consists of thirteen Articles and three Appendices broadly dealing with Conservation of biodiversity and the natural environment within the member States through a number of agreed measures.

11.2.3 IFC Performance Standard 6

IFC Performance Standard 6 concerning Biodiversity Conservation and Sustainable Management of Living Natural Resources recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development (IFC, 2012). The standard is guided by the Convention on Biological Diversity in addition to setting out guidelines for the preservation of ecosystem services.

Performance Standard 6 describes ecosystem services as the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organized into four types:

- **Provisioning Services**: the products people obtain from ecosystems (e.g. food, water, timbers, fibers, medicinal plants);
- **Regulating Services**: which are the benefits people obtain from the regulation of ecosystem processes (surface water purification, carbon storage and sequestration, climate regulation, protection from natural hazards);
- **Cultural Services**: which are the non-material benefits people obtain from ecosystems (e.g. natural areas that are sacred sites and areas of importance for recreation and aesthetic enjoyment); and,
- **Supporting Services**: which are the natural processes that maintain other services (e.g. soil formation, nutrient recycling, primary production).

Informed by the risks and impacts identification process, this Performance Standard should be applied to projects:

- Located in modified, natural and critical habitats;
- That potentially impact on or are dependent on ecosystem services over which the project proponent has direct management control or significant influence; or,
- That include the production of living natural resources (e.g. agriculture, animal husbandry, fisheries, forestry).

It states that the impact identification process should consider direct and indirect project-related impacts on biodiversity and ecosystem services and identify any significant residual impacts. The project proponent should seek to avoid impacts on biodiversity and ecosystem services, and, where avoidance is not possible, measures to minimize impacts and restore biodiversity and ecosystem services should be implemented.

The risks and impacts identification process should take account for the differing values attached to biodiversity and ecosystem services by Affected Communities, and where appropriate other stakeholders.

11.2.4 National Legislation

11.2.4.1 The Wildlife Protected Areas Act (1995)

The Protected Areas Act was established under Royal Decree No. M / 66 in 1995. The primary objectives of this Act are to conserve and develop wildlife in the Kingdom of Saudi Arabia. The principal provisions of the act relate to:

- Protected areas declaration procedures (Articles 3, 4 and 5).
- Protected areas management (Articles 6 and 7).
- Establishment of the guard force (rangers) (Article 8).
- Acts prohibited in the protected areas (Article 13).

11.2.4.2 The Wild Animals and Birds Hunting Act

The Wild Animals and Birds Hunting Act was implemented in 1999. The primary objectives of this Act are to regulate hunting of wild animals and birds; and to ensure the preservation of the nation's fauna by providing opportunities for wild animals and birds to breed.

The principal provisions of the act relate to:

- Issuing of hunting permits (Article 2).
- Acts prohibited by the Act (Article 4).
- Species that are protected from hunting (Article 5).

The Ministry of Interior, which is the authority responsible for regulating hunting activities, has in cooperation with the Saudi Wildlife Authority (SWA), specifies the periods and locations for hunting annually. Under this act, there is currently a ban on hunting migratory birds, due to concerns of avian bird flu. Hunting is also banned within the 16 designated protected areas of the Kingdom of Saudi Arabia.

Engaging in hunting activities without obtaining a license is contrary to the system of wild animals and bird hunting, and is considered as a violation of the agricultural land use purposes.

The falcon hunting season in the Kingdom of Saudi Arabia is from October to March.

11.2.4.3 The Act on Trade in Endangered Wildlife Species and their Products

The Act on Trade in Endangered Wildlife Species and their Products was implemented in 2000. The primary objectives of this act are to regulate the trade in wildlife and wildlife products by the system of import/export permits according to the rules of the Convention on International Trade of Species (CITES).

The principal provisions of the act relate to:

- Trade in wildlife and products are prohibited without the appropriate permit from the National Commission for Wildlife Conservation and Development (NCWCD) (Article 3).
- The NCWCD should issue a list of endangered species with the agreement of the Ministry of Agricultures (Article 4).
- A fee of SAR 50 should be collected, for the Treasury, for each permit issued (Article 5).

11.2.4.4 The Forest and Rangeland Act

The Forest and Rangeland Act was implemented in 1979. The primary objectives of this act are to ensure the conservation and rational exploitation of the forests and rangelands.

The principal provisions of the act relate to:

- Afforestation in public and village forest lands (Articles 6, 7 and 8).
- Rational exploitation of the forest products (Articles 9, 10 and 11).
- Acts prohibited in the forests (Article 12).

11.3 Baseline Environmental Conditions

11.3.1 Protected Areas

11.3.1.1 IUCN Protected Areas (International)

The IUCN has listed 16 Protected Areas within the Kingdom of Saudi Arabia. An IUCN Protected Area is defined as: '*an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means'*.

The nearest IUCN Protected Areas to the Dumat al Jandal Wind Energy Park are At Tubayq, Al Khunfah and Harrat Al Harrah Protected Areas (Figure 11.1).

- **Al Khunfah Protected Area (located approximately 136km south west of the development site):** This is an IUCN Category VI site. The Al Khunfah protected area was declared in 1988 to protect the then largest population of sand gazelle in Saudi Arabia, and to conserve a large tract of sandy gravel plain bordering the western edge of the Great Nafud (Child and Grainger 1990).

  The definition for IUCN Category VI Protected area with sustainable use of natural resources is to:

  "*Conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area*" (IUCN, 2012).

- **At Tubayq Protected Area (Located approximately 170km west of the development site)**: This is an IUCN Category III site and covers an area of c.12, 200km2 south of Harrat Al Harrah. The site consists primarily of desert and sandstone rocky plateaus and is one of the last remaining strongholds for the Nubian Ibex *Capra nubiana*.

  The definition for IUCN Category III Natural Monument or Feature sites is:

  "*These are comparatively smaller areas that are specifically allocated to protect a natural monument and its surrounding habitats. Natural Monuments or Features can be natural in the wholest sense, or include elements that have been influenced or introduced by humans. The latter should hold biodiversity associations or could otherwise be classified as a historical or spiritual site, though this distinction can be quite difficult to ascertain. As such, the classification then falls into two subcategories, those in which the biodiversity in uniquely related to the conditions of the natural feature, and those in which the current levels of biodiversity are dependent on the presence of the sacred sites that have created an essentially modified ecosystem. Natural Monuments or Features have a high cultural or spiritual value which can be utilized to gain support for conservation challenges.*" (IUCN, 2012)

- **Harrat Al Harrah Protected Area (located approximately 38km north west of the development site)**: This is an IUCN Category IV site and covers an area of 12,150km2 the landscape is dominated by numerous uplifted extinct volcanic cones and black basaltic boulders of the middle Miocene, making vehicle access mostly impossible. The Harrat al Harrah Protected Area was one of the initial biodiversity reserves established in Saudi Arabia (Child & Grainger, 1990; Seddon et al., 1997). The reserve provides habitat to over 250 species of plants, 50 species of birds and 22 species of mammals (Nader 1995; Seddon et al. 1997). It is located approximately 26km south of the development area

  The definition for IUCN Category IV Habitat/Species Management Area sites is:

  "*Habitat/Species Management Areas focus on more specific areas of conservation in correlation to an identifiable species or habitat that requires continuous protection. These protected areas will be sufficiently controlled to ensure the maintenance, conservation and restoration of particular species and habitats - possibly through traditional means - and public education of such areas is widely encouraged* *as part of the management objectives. Habitat or Species Management Areas may exist as a fraction of a wider ecosystem or protected area and may require varying levels of active intervention including - but not limited to - the prevention of poaching, creation of artificial habitats, halting natural succession and supplementary feeding practices*" (IUCN, 2012).

This site was in part designated to afford protection to the Houbara bustard *Chlamydotis (undulata) macqueenii.*

The development site is also located in proximity to the **Northern Wildlife Management Zone** which is designated as a Category VI Protected area with sustainable use of natural resources.

Category VI protected areas do conserve biodiversity, particularly at ecosystem and landscape scale, but the aim would not be to protect them strictly from human interference. Although scientific research may be important, it would be considered a priority only when applied to sustainable uses of natural resources, either in order to improve them, or to understand how to minimize the risks to ecological sustainability (IUCN, 2012). Therefore a key objective of this category of Protected Area is to promote the sustainable use of natural resources ensuring consideration is given to the ecological, economic and social dimensions.

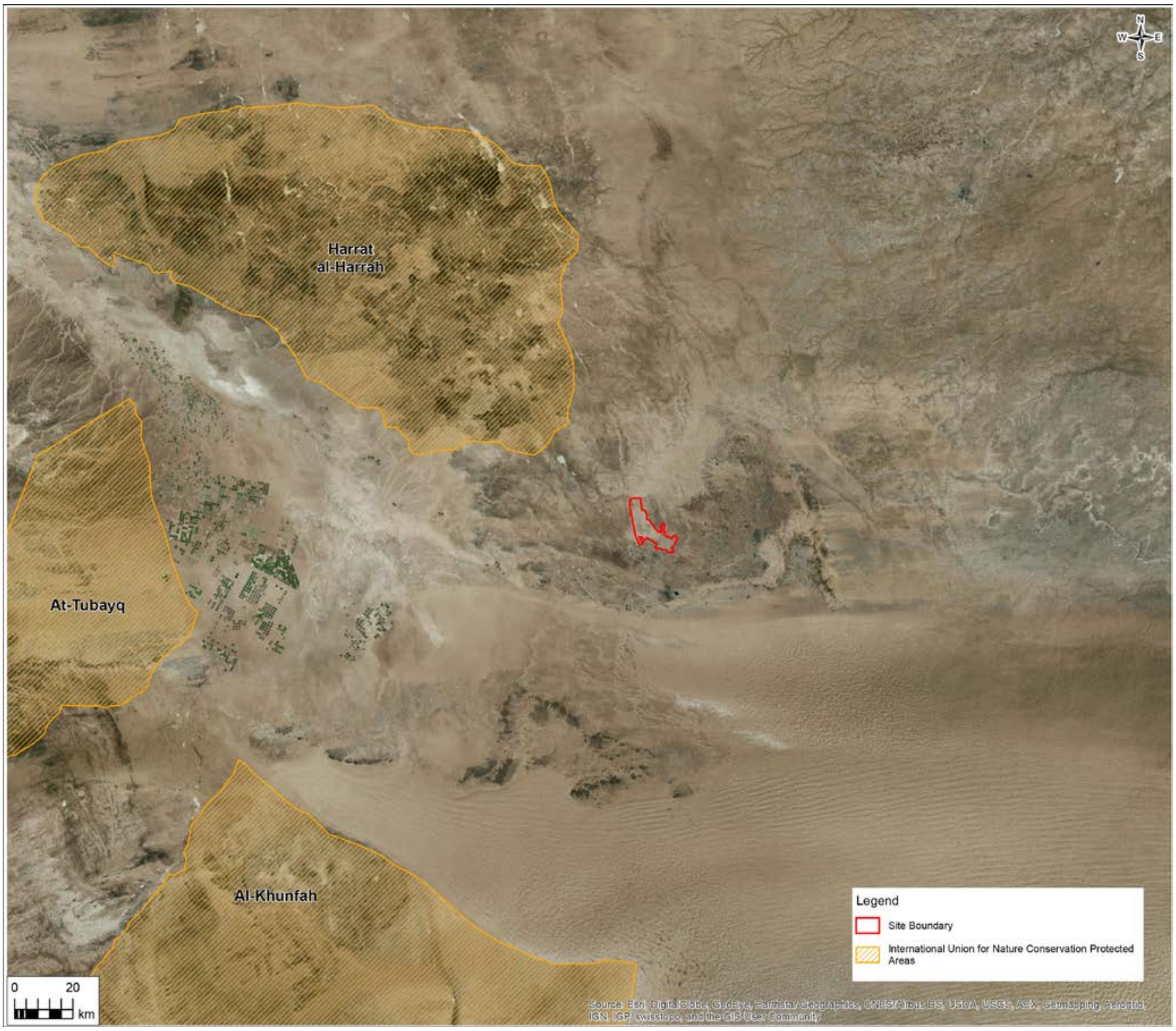

Figure 11.1: IUCN Protected Areas in Saudi Arabia

11.3.1.2 Important Bird and Biodiversity Areas (International)

Important Bird and Biodiversity Areas (IBAs) are key conservation areas which are identified using internationally agreed criteria applied locally by BirdLife Partners and experts (BirdLife International, 2017). There are over 12,000 recognized sites which make up the largest global network of significant biodiverse sites.

Four sites within 300km of the Dumat Al Jandal development site have been summarized in Table 11-1. The IBAs are arranged by their distance from the development site; all of the IBAs listed are in the Kingdom of Saudi Arabia. Each qualifying bird species has been listed by its presence within the designated site under four headings; resident (year-round), breeding-only, non-breeding-only or on passage. The nearest IBA site is 13km from the development site, Dawmat al Jandl Wetland (variation on spelling utilized by BirdLife International).

At the time of writing there was no clear designated species data available for the Dawmat al Jandl Wetland IBA. Due to the close proximity of the IBA to the development site it was visited on a number of occasions in order to characterize the bird activity within the IBA, particularly at the large man-made reservoir and associated irrigation ditches (Appendix F). The desktop study revealed historic numbers of over-wintering Eurasian coot and large flocks of white-winged black tern (c.>1000) in late April may be species that factor in the designation of the IBA (BirdLife International, 2017) although this could not be confirmed.

Table 11-1: Summary of IBAs in relation to Dumat Al Jandal (BirdLife, 2016).

IBA	Country	Description	Habitat	Size (ha)	Distance from Dumat Al Jandal (km)	Number of Qualifying Species			
						Resident	Breeding	Winter	Passage
Dumat Al Jandal Wetland	Saudi Arabia	Historically one of the few remaining wetlands in the northern desert surrounded by marshland. Now a man-made reservoir surrounded by agricultural holdings and the town of Dumat Al Jandal.	Open raised permanent reservoir basin with irrigation channels running to agricultural areas punctuated by very small, scattered remains of marshland.	2,500	13	-	-	-	-
Harrat al-Harrah	Saudi Arabia	Large desert with basalt boulder fields and volcanic cones.	Silt flats, salt flats, shallow wadis, permanent reservoir and small scrub.	1,377,500	50	9	2	3	2
At-Tubayq	Saudi Arabia	Raised platform of old, dark sandstone 300-400m above a sandy plain.	Ephemeral plant growth after rain, drought resistant shrubs and grass.	1,220,000	150	1	1	-	-
Jabal Aja and Northern Ha'il	Saudi Arabia	Mountainous region adjacent to semi-desert and the Jabal Aja and Northern Ha'il city south of the An Nafud Desert.	Extensive granite mountains with deep *Acacia*-lined valleys and adjacent semi-desert. One of the most vegetated areas in the north; the desert and sandstone hills bloom during wet springs.	400,000	280	4	1	2	6

N.B. No Population Data for Trigger species is available for Dumat Al Jandal.

11.3.1.3 Important Plant Areas (International)

There are over 100 provisional Important Plant Area (IPA) sites that have been identified in the Kingdom of Saudi Arabia, Oman and Yemen. However no IPA have been formally recognized and officially designated. Therefore there are no such sites within 2km of the development site.

11.3.1.4 Biodiversity Protection Areas (National)

A network of national sites recognized for their biological conservation value fall under the jurisdiction of the former National Commission for Wildlife Conservation & Development, now the Saudi Wildlife Authority. These sites are not formally designated. There are no such sites within 25km of the development site and the nearest of these sites to the development site are the Harrat at Harrah, At Tubayq and Al Khunfah Protected Areas (Figure 11.2).

Figure 11.2: National Designated and Proposed Protected Areas

11.3.2 Ornithological Baseline

The Dumat Al Jandal development site is located in a region notable for the migration of birds along a broad-fronted west to east orientated migratory flyway, the East Asian/East African flyway, which is active in spring (eastward movement) and autumn (westward movement) (BirdLife International, 2010)(Section 11.3.2.2, Figure 11.3). There is also a general wave of bird migration movement through the Arabian Peninsula in spring (northward movement) and autumn (southward movement) which may result in increased bird activity within the development site during migration periods (Zalles & Bildstein, 2000). A primary ecological concern of wind energy development is the potential impact upon birds and as such birds are a key focus of the ecological assessment of the Dumat Al Jandal Wind Energy Park. The assessment has been built upon best practice survey guidance (Scottish Natural Heritage (SNH), 2014) following guidelines set by the International Finance Corporation (IFC) and BirdLife International (Section 11.3.2.1).

Wind energy developments pose three main potential risks to birds (SNH, 2014):

- **Collision** with wind turbines and other infrastructure leading to injury or mortality.
- **Displacement or barrier effects** of the wind farm development as birds may avoid the area due to the construction and operation of the wind farm.
- **Direct habitat loss** due to the wind farm development and associated infrastructure which may impact upon habitats supporting breeding, wintering and migratory species e.g. seasonal wadi systems.

To appropriately assess each of these risks, a detailed understanding of the bird activity within the development site and surrounding airspace is required. A more detailed legislative review relevant to the ornithological baseline has been undertaken, and is reported in the Phase 3: Ornithology Baseline Survey Report (Appendix F). This also includes a review of industry best practice survey guidelines for assessing the impact of onshore wind farms.

11.3.2.1 Legislation and Guidance

The following have been considered in addition to the legislation outlined in Chapter 2 of the ESIA due to the assessment of wild birds on passage from international areas:

- Directive 2009/147/EC of the European Parliament and of the Council (Birds Directive, 2009).
- The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1983).
- International Union of Conservation of Nature Red List of Threatened Species (IUCN, 2017).
- Key conservation issues for migratory bird species on the world's major flyways (Kirby et al. 2008).
- Wind farms and Birds: An analysis of the effects of wind farms on birds, and guidance on environmental assessment criteria and site selection issues (Langston & Pullan, 2003).
- Recommended bird survey methods to inform impact assessment of onshore wind farms (SNH, 2014).

Scottish Natural Heritage guidance (SNH, 2014) is widely accepted as the global benchmark of ornithological assessment of wind energy development and has been followed as appropriate within this assessment.

11.3.2.1.1 International Finance Corporation Guidance

The International Finance Corporation (IFC) developed World Bank Group Environmental Health and Safety Guidelines for Wind Energy (IFC, 2015) states the following must be considered during pre-construction assessment of birds:

Surveys should target those with a special international or national conservation status, endemic species, and species that are at elevated risk of impact from wind energy facilities. For example, species with a relatively high collision risk include certain soaring, aerial-displaying, and/or migratory birds and flocking birds, as well as birds of prey (Guideline 27).

Species with a relatively high risk of visual disturbance include open-country species that instinctively avoid tall structures. Some species may be attracted to wind energy facilities as perches or feeding areas, which could further increase potential for collision. Species at risk of collision with associated transmission lines include relatively heavy-bodied birds with limited maneuverability (e.g., vultures, bustards, waterfowl, cranes, storks, pelicans, herons, flamingos), as well as flocking bird species (Guideline 27).

Surveys should take into consideration certain periods during the year when the project site may have a greater or different ecological function or value (e.g., migration, breeding season, or winter seasons). Surveys should usually be conducted for at least one year when at-risk wildlife is identified. Longer surveys may sometimes be necessary in areas with exceptional aggregations of at-risk migratory birds and where existing biodiversity data are limited (Guideline 27).

Surveys should be designed and implemented to adequately guide the micro-siting of turbines (and turbine selection) to minimize collision risks to birds. This is normally expected to entail gathering relatively precise information on the spatial patterns of site utilization by at-risk wildlife species, as well as consideration of the locations of certain topographic, ecological, or other landscape features that may attract or otherwise concentrate the activity within the project area and its surrounding landscape. Specific data-gathering methods and study designs should be selected based on site and species-specific considerations, guided by technical experts, and may include vantage point (VP) surveys, point count surveys, ultrasound acoustic methods, remote-sensing data-gathering techniques, and/or other techniques to understand movement patterns, as appropriate (Guideline 28).

The use and effectiveness of radar and/or other remote-sensing technologies in pre-construction studies should be evaluated on a project-by-project basis and may be appropriate to supplement observer-based surveys; depending on the circumstances. Remote-sensing technologies are particularly useful at offshore wind facilities, as observer-based studies are more difficult and expensive in the offshore environment (Guideline 29).

Depending on the location of the wind energy facility and on species-specific considerations, Collision Risk Modelling may be also appropriate, especially when wind energy facilities are located close to areas of high biodiversity value. The utility of CRM is to be evaluated on a project-by-project basis with qualified experts. (Guideline 31).

11.3.2.1.2 BirdLife International Guidance

BirdLife International produced standardized guidance on birds and wind farms within the Rift Valley/Red Sea flyway through its Migratory Soaring Birds (MSB) initiative (BirdLife International, 2012). Although the Dumat Al Jandal site is not located directly on this flyway the guidance was also utilized to inform the assessment process. The MSB project, led by BirdLife International in conjunction with the United Nations Development Program (UNDP) and Global Environment Facility (GEF) outlines four broad requirements for baseline surveys as follows:

- **Migratory bird surveys** which should take place for a minimum of a year to cover the migration seasons. The baseline survey should include vantage point surveys undertaken during migration periods to assess the potential risks to migratory soaring birds, particularly at or near migration bottlenecks.
- **Breeding bird surveys** to provide baseline data on which to assess the potential impact of a development on breeding species in the area.
- **Vulnerable and protected species-specific surveys** for species that need individual assessment, e.g. owls, nightjars, locally breeding raptors, colonial breeding species etc., which may be present in the area.
- **Wintering bird surveys** may also be required, which could include non-breeding surveys of resident species, and of over-wintering migrants.

11.3.2.2 Migration Routes

The East Asian/East African Flyway (Figure 11.3) is one of three connecting the Palearctic and Africa regions; the other two, the East Atlantic Flyway and Red Sea/Rift Valley Flyway are well-known and well-studied; especially at key bottleneck sites (Zalles & Bildstien, 2000, Kirby et al., 2008, Bildstein & Sandor, 2016). Collectively, these three migration routes make up the world’s largest bird migration system (BirdLife International, 2010).

The East Asian/East African Flyway is a broad-fronted, west to east orientated route between East Asia and Africa (BirdLife International, 2010). It is a multi-species flyway; shorebirds, soaring birds and passerines migrate along the broad route which is active in spring (eastward movement) and autumn (westward movement) (Boere & Stroud, 2006, Kirby et al., 2008, BirdLife International, 2010).

The route passes through a vast area in the Middle East covering Iran, Iraq, Syria and the Kingdom of Saudi Arabia. There is a lack of available information on specific migration routes and bottleneck sites in the region, especially in northern part of the Kingdom of Saudi Arabia. Associated literature specifically identifies the lack of available historic data within these countries for migratory species utilizing the flyway (Stroud et al., 2006).

There is a record of a migration route taken by a Russian satellite-tagged steppe eagle during the autumn migration period in 2016 (Satellite Tracking EU, 2017). The migration route followed by the individual crossed the northern part of the Kingdom of Saudi Arabia from the north-east to the south-west, passing within 20km of the Dumat Al Jandal site on 13 September 2016. The bird continued south-west reaching the Taif Escarpment before flying south to the Strait of Bab-el-Mandab and crossing into Africa at Djibouti. This is a portion of steppe eagle (autumn) migration that is well-known (Zalles & Bildstein, 2000, Meyburg, 2003). Historically, steppe eagle have migrated in a large loop around the Red Sea, the autumn migration roughly following the above route, whilst the return spring migration heads through north-east Africa, passing ‘bottlenecks’ at Suez and Eilat (Zalles & Bildstein, 2000, Bildstein & Sandor, 2016, IBRC, 2017). It is thought that an increasing number of steppe eagles are wintering within the Arabian Peninsula and therefore these routes may be increasingly more variable (Meyburg, 2003).

Although the flyway is less-studied than its counterparts it can be determined there are no major bottleneck sites near Dumat Al Jandal (BirdLife International, 2016). The closest major bottleneck sites lie in Jordan and Israel greater than 400km west of the development site and are associated with the north to south orientated Rift Valley/Rea Sea flyway (Bildstein & Sandor, 2016, IBRC, 2017).

Broad-fronted movements of black kite, all harrier species and both kestrel species occur across the Arabian Peninsula in spring (Zalles & Bildstein, 2000).

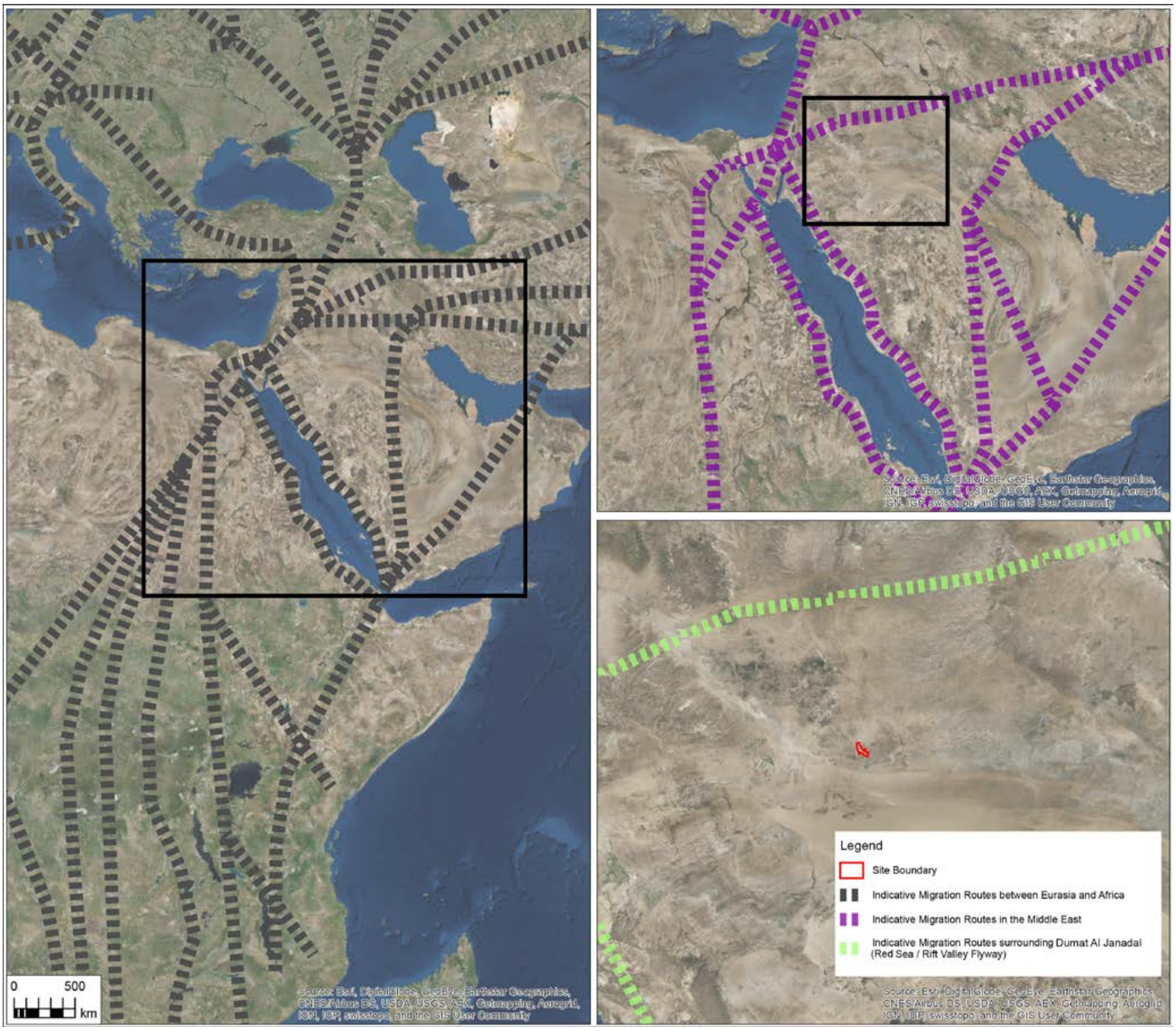

Figure 11.3: East Asian/East African Flyway

11.3.2.3 Key Species

The key species for this region in terms of wind energy development are the soaring and sub-soaring species which are more susceptible to collision due to their flight behaviors (Barrios & Rodriguez, 2004, SNH, 2010, BirdLife International, 2012, IFC, 2015, Newton, 2016). This is due to the 'soaring-gliding' flight mode which is utilized for migration by these species. Where possible, the birds gain height and soar on thermals before gliding (losing height) until the next thermal is reached, this repeated process can potentially result in increased flight activity within the collision risk height zone of wind turbines.

Vultures and eagles are most dependent on soaring-gliding, followed in descending order by *Buteo* buzzards, *Milvus* kites, *Accipter* hawks, and *Pernis* honey buzzards, and then by *Circus* harriers and osprey. Falcons are more active fliers, less dependent on updrafts, but make use of them when available (Newton, 2016). Storks and cranes also utilize this flight mode (BirdLife International, 2012).

Thirty-seven species of raptor regularly occur in the Kingdom of Saudi Arabia and 33 in nearby Iraq, almost all of these raptors migrate to a certain extent within their ranges (Zalles & Bildstein, 2000) and a large proportion of these species may occur at the Dumat Al Jandal site in the north of the Kingdom of Saudi Arabia. The most numerous raptors on the adjacent Red Sea/Rift Valley flyway are black kite, honey buzzard, steppe buzzard and steppe eagle (Zalles & Bildstein, 2000) and these species are likely to occur within the development site. As mentioned in Section □broad-fronted movements of black kite, all harrier species and both kestrel species occur across the Arabian Peninsula in spring (Zalles & Bildstein, 2000). Other key species at within the development site may include those found at the nearest IBA, Dawmat al Jandl IBA.

11.3.2.4 Migration Periods and Variability of Bird Movement

Raptors, and other migrant species, generally move south from Europe and Central Asia into Africa throughout August until early-November with northerly spring migration occurring late-February to mid-May utilizing the Middle East as a land bridge (Zalles & Bildstein, 2000, Bildstein & Sandor, 2016).

The migration pattern of these birds varies between autumn and spring periods as the birds utilize different pathways within the main migration corridors. This is particularly notable at the nearest well-studied migration sites in Jordan where, across six well-studied sites, up to 32 species of raptor are recorded. Although higher populations migrate in autumn, as juveniles increase the number of birds migrating, this is in a broader-front towards the south of the flyways. In the Middle East spring passage (northward) is generally more significant than autumn (southward) (Bildstein & Sandor, 2016).

As a general rule, however, the reverse trend is evident further north on the flyways whereby autumn is significantly busier than spring. The migration bottleneck at Batumi (Georgia) 1300km north of Dumat al Jandal follows this trend. It is deemed to be the most important autumn flyway in Eurasia, with over a million raptors recorded on passage each autumn (Bildstein & Sandor, 2016).

Migration activity varies temporally within each individual season as different species migrate at differing times. There is evidence of this during spring migration at one of the main bottleneck sites in the Middle East, Eilat, as steppe buzzard and steppe eagle move north through the site in significant numbers throughout March. In contrast, honey buzzard aren’t recorded until late April and early May when the majority of the species (>400,000 birds) pass through in a matter of days (IBRC, 2015, Bildstein & Sandor, 2016).

Weather conditions can have an effect on the variability of bird migration. Rain, mist, heavily overcast conditions and strongly opposing winds can temporarily deter birds from migrating. Migration paths can shift laterally by several kilometers due to cross winds and can be restricted altogether by strong winds in any direction which reduce the prevalence of thermals (Newton, 2016). Weather conditions can also affect food availability and migration may be delayed or staging sites altered due to the level of food availability pre-migration and along migration corridors (Lopez-Lopez et al., 2014). This can influence the location of stop-overs; short stage migration with many stop-overs when food availability is low and longer, more direct, migration with fewer stop-overs when food availability is high. This variation can potentially impact upon the detectability of the birds along migration corridors.

Surveys at Dumat Al Jandal have been tailored to account for the variability and trends in bird migration.

11.3.2.5 Tafila Wind Farm

The Tafila Wind Farm in the Hashemite Kingdom of Jordan is the first commercial utility-scale wind project in the region (Masdar, 2016). The 117 megawatt (MW) site became operational in September 2015 and is the only operational example which is comparable to the proposed Dumat al Jandal Wind Energy Park.

The Tafila site lies along the Red Sea/Rift Valley flyway, in close proximity to the an IBA designated for 39 bird species. Baseline bird surveys were carried out across 34 days between October 2011 and September 2012 (Jordan Wind Project Company (JWPC), 2012) with further surveys conducted during the following spring migration (27 February to 18 May 2013) to inform the impact assessment of the wind farm (JWPC, 2013). These surveys combined sampling approaches, such as line transects and spot counts, with VP surveys. International guidance (BirdLife International, 2012) was followed in relation to general survey and SNH guidance (SNH, 2000) utilized for VP survey methodology and CRM.

11.3.3 Mammals

Saudi Aramco has identified ecologically sensitive mammal species within the Kingdom of Saudi Arabia (SAEP-396 Terrestrial Ecology Surveys), based on meeting one or more of the following criteria:

1. Any species that the International Union for Conservation of Nature (IUCN) has evaluated as being Internationally Threatened; and/or

2. Any species that the IUCN has evaluated as being Regionally Threatened (NB: the IUCN has published regional assessments for reptiles and carnivorous mammals only); and/or

3. Any species that the former National Commission for the Conservation of Wildlife and Development (NCWCD) has evaluated as being Nationally Threatened (NCWCD Criteria 1); and

- is endemic to Saudi Arabia or the Arabian Peninsula (NCWCD Criteria 2); and/or
- the conservation of the population within Saudi Arabia is essential to the conservation of the species globally (NCWCD Criteria 3); and/or
- is a relict species of global, regional, or national significance (NCWCD Criteria 4); and/or
- Is of special ecological importance within Saudi Arabia (i.e. it fulfils a vitally important function in an ecosystem, such as providing key habitat for other species (NCWCD Criteria 5).

These mammal species are listed in Table 11-2 (excluding bats), The conservation status of these species is based on a review of the International Union for the Conservation of Nature (IUCN) publication Regional Red List Status of Carnivores in the Arabian Peninsula (Mallon et al, 2011); and the IUCN Red List of Threatened Species (www.iucnredlist.org). An evaluation of the likely presence of these ecologically sensitive species has also been completed using published distribution maps.

Table 11-2: Ecologically Sensitive Mammal Species and Likely Presence within Development Site

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within development site
Asiatic Jackal	*Canus aureus*	1	EN Decreasing	LC Increasing	Absent
Arabian Wolf	*Canis lupus arabs*	1, 2, 5	EN Decreasing	LC Stable	Likely Absent
Nubian Ibex	*Capra nubiana*	1, 3		VU Decreasing	Possible
Caracal	*Caracal caracal*	1, 5	LC	LC Unknown	Absent
Sand Cat	*Felis margarita*	1, 2	NT Decreasing	NT Decreasing	Absent
Wild Cat	*Felis silvestris*	1	NT Decreasing	LC Decreasing	Absent
Arabian Mountain Gazelle	*Gazella gazella cora*	1, 2		VU Decreasing	Absent
Farasan Gazelle	*Gazella gazella farasani*	1, 2		VU Decreasing	Absent

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within development site
Arabian Sand Gazelle	*Gazella subgutturosa*	1, 2		VU Decreasing	Possible
Indian Grey Mongoose	*Herpestes edwardsii*	1	DD	LC Stable	Absent
Striped Hyaena	*Hyaena hyaena*	1	EN Decreasing	NT Decreasing	Possible
Indian crested porcupine	*Hystrix indica*	1, 4		LC Stable	Absent
Arabian Hare	*Lepus capensis arabica*	1, 2		LC Decreasing	Possible
Honey Badger	*Mellivora capensis*	1	NT Decreasing	LC Decreasing	Possible
Arabian Oryx	*Oryx leucoryx*	1, 2		VU Stable	Absent
Arabian Leopard	*Panthera pardus*	1, 2, 5	CR Decreasing	NT Decreasing	Absent
Hamadryas Baboon	*Papio hamadryas*	3		LC Increasing	Absent
Blanford's Fox	*Vulpes cana*	1, 4	VU Decreasing	LC Stable	Absent

IUCN International Criteria

LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; DD: Data Deficient

National Conservation Criteria

1: Nationally threatened species; 2: Species that are endemic to Saudi Arabia, the Arabian Peninsula, the Red Sea or the Gulf; 3: Species in which the conservation of populations within Saudi Arabia is essential to the conservation of the species globally; 4: Relict species of global, regional or national significance; 5: Species of special ecological importance.

11.3.4 Bats

The distribution and population status of bat species within the Kingdom of Saudi Arabia is likely to be under-recorded. A precautionary approach has therefore been adopted when interpreting published resources, and in particular determining the conservation status of species. For the purposes of this desk-top review, the IUCN Red List of Threatened Species (www.iucnredlist.org) has been utilized alongside the publication Bats of Saudi Arabia (Al-Agaili, 2003).

Table 11-3 lists the bat species identified by Al-Agaili (2003), and the global IUCN status is based on the IUCN Red List of Threatened Species (www.iucnredlist.org). An evaluation of the likely presence of the bat species identified has also been completed using published distribution maps.

Table 11-3: Bat Species and Likely Presence within Development Site

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within development site
Family *Pteropodidae* Fruit Bats					
Ethiopian epauletted fruit bat	Epomophorus *labiatus*	-	-	LC Stable	Absent

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within development site
Egyptian fruit bat	*Rousettus aegyptiacus*	-	-	LC Stable	Absent
Straw-colored fruit bat	*Eidolon helvum*	-	-	NT Decreasing	Absent
Family *Rhinopomatidae* Mouse-tailed Bats					
Greater mouse-tailed bat	*Rhinopoma microphyllum*	-	-	LC Stable	Absent
Lesser mouse-tailed bat -	*Rhinopoma hardwickii*	-	-	LC Stable	Present
Muscat mouse-tailed –	*Rhinopoma muscatellum*	-	-	LC Unknown	Absent
Family Emballonuridae - Sheath-tailed Bats					
Egyptian tomb bat	*Taphozous perforates*	-	-	LC Stable	Absent
Naked-bellied tomb bat	*Taphozous nudiventris*	-	-	LC Stable	Absent
Family Nycteridae - Slit-faced Bats					
Aden slit-faced bat	*Nycteris thebaica*	-	-	LC Unknown	Absent
Family Rhinolophidae - Horseshoe Bats					
Geoffroy's horseshoe bat	*Rhinolophus clivosus*	-	-	LC Stable	Absent
Lesser horseshoe bat	*Rhinolophus hipposideros*	-	-	LC Decreasing	Absent
Blasius' horseshoe	*Rhinolophus blasii*	-	-	LC Decreasing	Absent
Mediterranean Horseshoe Bat	*Rhinolophus euryale*	-	-	NT Decreasing	Absent
Family Hipposideridae - Leaf-nosed Bats					
Lesser leaf-nosed bat	*Hipposideros caffer*	-	-	LC Decreasing	Absent
Small leaf-nosed bat	*Hipposideros megalotis*	-	-	LC Unknown	Absent
Persian leaf-nosed	*Triaenops persicus*	-	-	LC Unknown	Absent
Trident leaf-nosed bat	*Asellia tridens*	-	-	LC Stable	Present
Small trident leaf-nosed bat	*Asellia patrizii*	-	-	LC Unknown	Absent
Family Molossidae - Free-tailed Bats					
European free-tailed bat	*Tadarida teniotis*	-	-	LC Unknown	Absent

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within development site
Egyptian free-tailed bat	*Tadarida aegyptiaca*	-	-	LC Unknown	Absent
Lesser free-tailed bat	*Tadarida pumila*	-	-	LC Unknown	Absent
Nigerian free-tailed bat	*Tadarida nigeriae*	-	-	LC Unknown	Absent
Midas free-tailed bat	*Tadarida midas*	-	-	LC Decreasing	Absent
Family Vespertilionidae - Vespertilionid Bats					
Notch-eared bat	Myotis emarginatus	-	-	LC Stable	Absent
Rufous mouse-eared	*Myotis bocagei*	-	-	LC Unknown	Absent
Botta's serotine bat	*Eptesicus bottae*	-	-	LC Unknown	Absent
Sind serotine bat	*Eptesicus nasutus*	-	-	LC Unknown	Absent
Kuhl's pipistrelle	*Pipistrellus kuhlii*	-	-	LC Unknown	Present
Arabian pipistrelle	*Pipistrellus arabicus*	-	-	DD Unknown	Absent
Bodenheimer's pipistrelle	*Pipistrellus bodenheimeri*	-	-	DD Unknown	Absent
Schlieffen's bat	*Nycticeinops schlieffeni*	-	-	LC Unknown	Absent
Lesser yellow house bat	*Scotophilus leucogaster*	-	-	LC Unknown	Absent
Hemprich's long-eared bat	*Otonycteris hemprichi*	-	-	LC Unknown	Absent
Grey long-eared bat	*Plecotus austriacus*	-	-	LC Unknown	Absent
Schreiber's long-winged bat	*Miniopterus schreibersii*	-	-	NT Decreasing	Absent
Common noctule	Nyctalus noctula	-	-	LC Unknown	Absent
Western barbastelle	*Barbastella barbastellus*	-	-	NT Decreasing	Absent
Family Emballonuridae					
Southern sheath-tailed	*Coleura afra*	-	-	LC Unknown	Absent
IUCN International Criteria LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; DD: Data Deficient					

11.3.5 Reptiles

Saudi Aramco has identified ecologically sensitive reptile species within the Kingdom of Saudi Arabia based on the criteria referenced in SAEP-396 Terrestrial Ecology Surveys. These reptile species are listed in Table 11-4 and this list is based on a review of the International Union for the Conservation of Nature (IUCN) publication *The Conservation Status and Distribution of Reptiles of The Arabian Peninsula* (Cox et al, 2012); and the IUCN Red List of Threatened Species (www.iucnredlist.org). An evaluation of the likely presence of these ecologically sensitive species has also been completed using published distribution maps.

Table 11-4: Ecologically Sensitive Reptile Species and Likely Presence within Development Site

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within development site
Saudi Fringed Fingered Lizard	Acanthodactylus gongrorhynchatus	1, 2	DD Unknown	DD Unknown	Absent
Levitons Cylindrical Skink	Chalcides levitoni	1, 2	DD Unknown	DD Unknown	Absent
Sarso Island Racer	*Coluber insulans*	1, 2	DD Unknown	DD Unknown	Absent
Braid Snake	*Coluber rhodorachis*	3			
Arabian Sand Boa	*Eryx jayakari*	3, 5	LC Stable	LC Stable	Present
Leviton's Leafnose Snake	Lytorhynchus gasperetti	1, 2	DD Unknown	DD Unknown	Absent
False Cobra	*Malpolon moilensis*	3, 5			
Arabian Blind Snake	*Myriopholis burii*	1, 2	DD Unknown	DD Unknown	Absent
Red Eyed Sea Snake	*Ophisops elbaensis*	1, 2	DD Unknown	DD Unknown	Absent
	Trapelus jayakari	1, 2	DD Unknown	DD Unknown	Absent
Horny Scaled Agama	*Trapelus ruderata*	3	LC Stable	LC Stable	Present
	Tropiocolotes wolfgangboehmei	1, 2	DD Unknown	DD Unknown	
Spiny Tailed Dhab	*Uromastyx aegyptia*	1, 3	VU Decreasing	VU Decreasing	
Oscillated Dab Tailed Lizard	*Uromastyx ocellatus*	3			
Yemen Monitor	*Varanus yemenensis*	1, 2, 5	DD Unknown	DD Unknown	Absent
Desert Cobra	*Walterinnesia aegyptia*	3	LC Decreasing	LC Decreasing	
IUCN International Criteria LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; DD: Data Deficient National Conservation Criteria					

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within development site
1: Nationally threatened species; 2: Species that are endemic to Saudi Arabia, the Arabian Peninsula, the Red Sea or the Gulf; 3: Species in which the conservation of populations within Saudi Arabia is essential to the conservation of the species globally; 4: Relict species of global, regional or national significance; 5: Species of special ecological importance.					

Cox et al (2012) have ascertained that the overall reptile species diversity is highest around the edge of the Peninsula and northern Saudi Arabia, and in proximity to the development site the number of species is listed as 29 – 35. This is illustrated on Figure 11.4. Within proximity to the development site, Cox et al (2012) estimate between 1 – 6 endemic species are present. Notwithstanding, many species within the Arabian Peninsula are data deficient and a precautionary approach has been taken when interpreting published data.

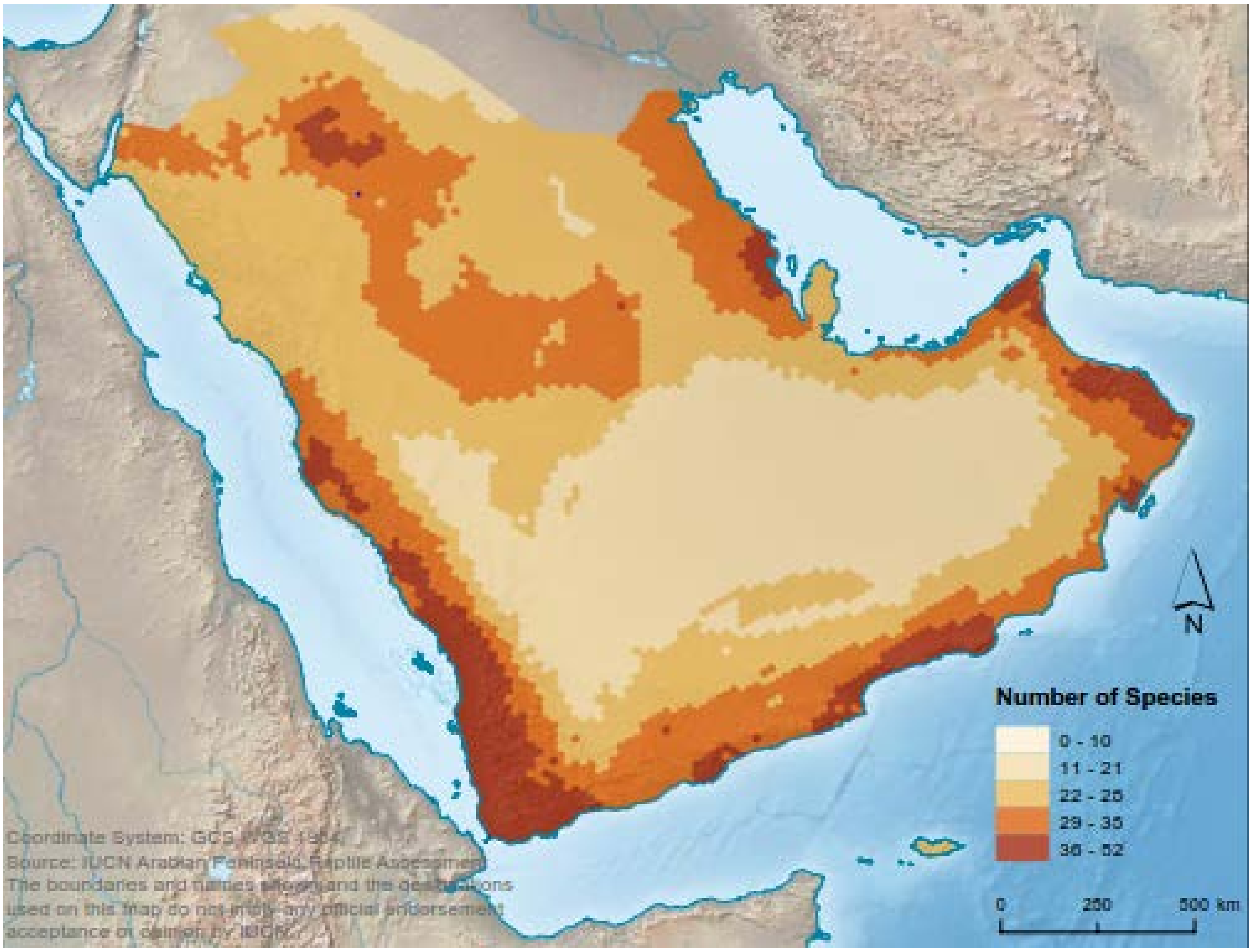

Figure 11.4: Species Richness of Reptiles in the Arabian Peninsula

11.4 Baseline Survey

11.4.1 Baseline Survey Design

The baseline survey methodologies are reported in the Dumat al Jandal Wind Energy Park Fatal Flaw Analysis and Baseline Survey report, the Dumat Al Jandal Baseline Ornithology Report (Appendix F) and Appendix H. These survey methodologies have been agreed with the project proponent and comply with national and international good practice guidelines.

The location of transect surveys, trail camera surveys and Anabat Express detector surveys are illustrated on Figure 11.5. The locations of the baseline ornithology Vantage Point surveys are illustrated on Figure 11.6.

The findings of the baseline surveys are summarized in the following sub-sections. Bird species are referred to using the English name throughout this chapter; a full list of the bird species recorded and their scientific, or Latin, names are provided in Appendix F.

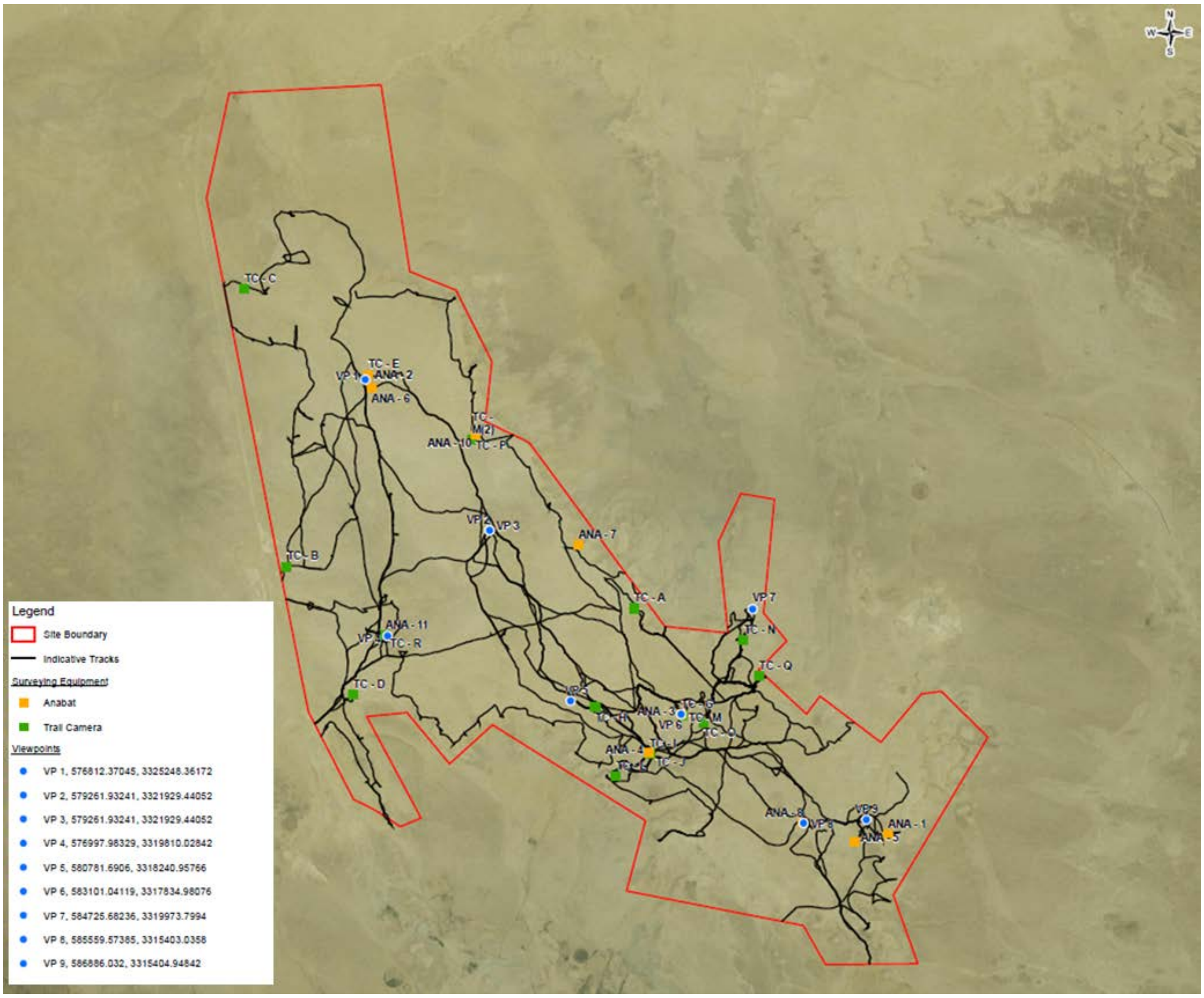

Figure 11.5: Remote Monitoring and Bird Transect Survey Layout.

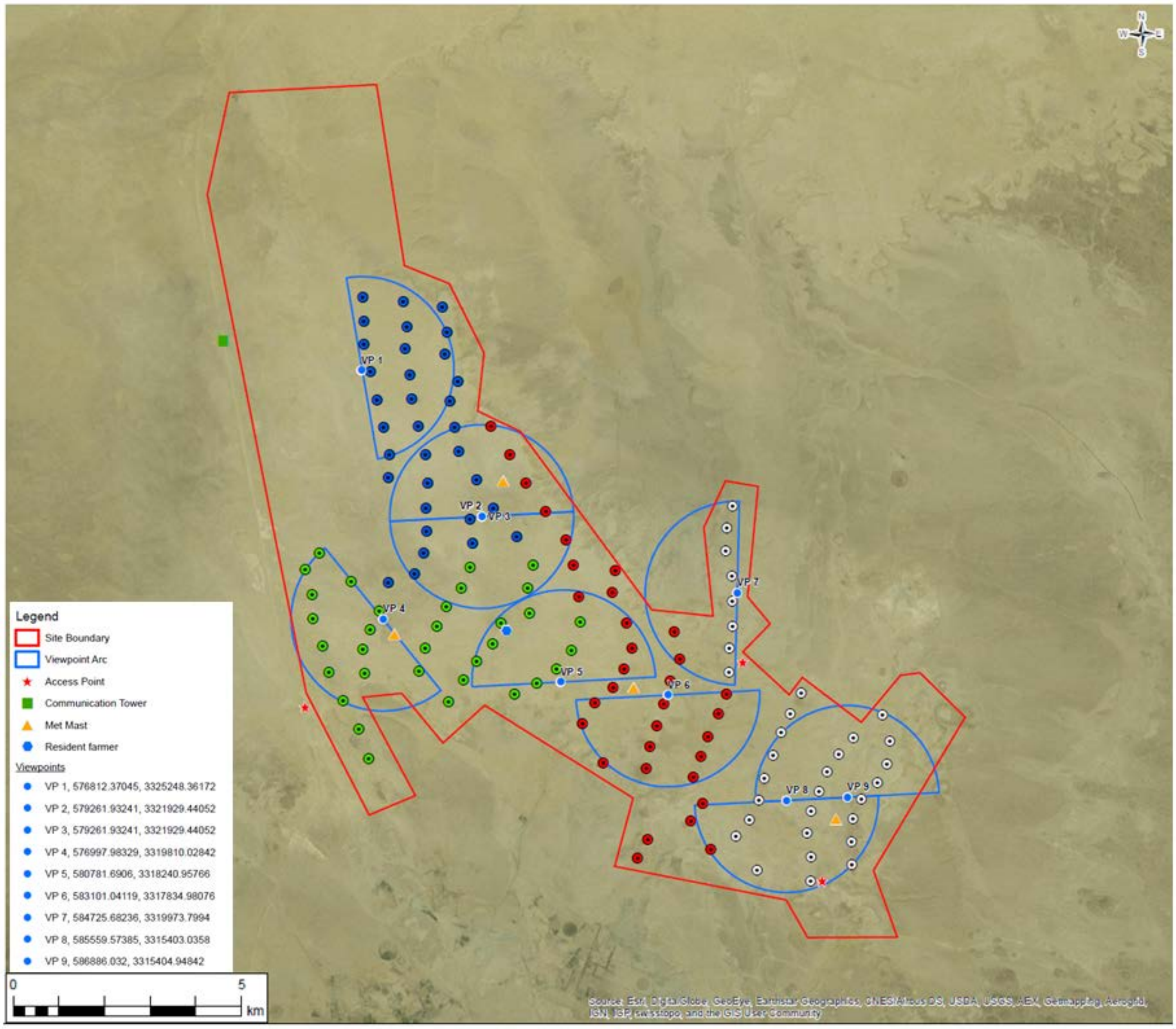

Figure 11.6: Vantage Point Survey Layout

11.4.2 Ornithology Surveys

Migratory, breeding and wintering ornithological surveys have been completed at the proposed Dumat Wind Energy Park. A combination of VP survey effort across two migrations seasons, spring and autumn 2017, and constant effort surveys were undertaken to achieve robust coverage of the development site. Upon completion of the surveys detailed data analysis, including Collision Risk Modelling, has been undertaken.

Over 450 hours of VP survey were undertaken during migration periods across nine separate VP locations to provide sufficient coverage of the proposed turbine layout. A total of 6160 target species individuals of 23 species were recorded during the survey which generated a total of 759 separate flight lines (Figures TB18:1-16, TB19:1-16). A further three target species were observed through constant effort surveys observations. The full ornithology baseline survey report is included within Appendix F.

11.4.2.1 Spring Migration Target Species Flights

Across the spring VP survey period 181 individual birds of 14 target species were recorded. The spring VP surveys generated a total of 131 flight lines.

Over ten flights were recorded for five species. These included:

- marsh harrier - 42 individuals and 32 flight lines;
- steppe buzzard - 36 individuals and 17 flight lines;
- Montagu's harrier – 20 individuals and 16 flight lines;
- pallid harrier – 18 individuals and 18 flight lines; and
- common kestrel – 14 individuals and 13 flight lines.

Ten or fewer flight lines were recorded for all other target species. An overview of the VP data from the spring migration period is presented in Table 11.5 The proportion of time spent flying within each height band is given to the nearest integer. It is worth noting that the proportion of flight seconds in each height band within the table correspond to the original height bands as detailed in Appendix F, as the flights were recorded prior to the turbine height amendments.

Flight lines for the target species recorded during the spring migration period are shown in Figures TB18:1 to TB18:15 (Appendix F). All flight lines shown within the figures are assigned a unique flying bout reference, related to the KSA species codes in Appendix F, which can be cross-referenced with the raw flight line data included in Appendix F. A flight activity heat map, showing the relative density of all target species flights in the spring period is also provided in Figure TB18:16 (Appendix F).

Table 11.5: Summary of all target species flight lines during the spring survey period

Species	Flights	Flight Time (Seconds)	Total number of individual birds	Max. number of birds observed concurrently	Band A %	Band B %	Band C %	Band D %
Black kite	6	1073	13	5	37	34	29	0
Common kestrel	13	1773	14	2	78	22	0	0
Eurasian sparrowhawk	1	60	1	1	0	0	100	0
European honey buzzard	1	882	3	3	0	0	53	47
Griffon vulture	1	5184	8	8	0	0	73	27
Hen harrier	3	508	4	2	77	12	11	0
Lesser kestrel	1	180	2	2	100	0	0	0
Long-legged buzzard	3	225	3	1	0	53	47	0
Marsh harrier	32	6221	42	5	43	40	16	<1
Montagu's harrier	16	1743	20	2	67	18	9	7
Pallid harrier	18	1092	18	1	81	5	8	5
Short-toed snake eagle	9	1867	5	1	2	52	46	0
Steppe buzzard	17	5304	36	9	0	9	33	58
Steppe eagle	10	1823	12	2	8	21	57	13

Species	Flights	Flight Time (Seconds)	Total number of individual birds	Max. number of birds observed concurrently	Band A %	Band B %	Band C %	Band D %
Total	**131**	**27935**	**181**	**-**	**-**	**-**	**-**	**-**

11.4.2.2 Autumn Migration Target Species Flights

Autumn migration surveys generated a total of 628 flight lines of 22 target species.

Over 50 individuals were recorded for six species:

- steppe buzzard - 5235 individuals and 192 flight lines;
- European honey buzzard - 184 individuals recorded and 31 flight lines;
- black kite – 119 individuals and 53 flight lines;
- pallid harrier - 95 individuals and 91 flight lines;
- marsh harrier - 85 individuals and 60 flight lines; and
- common kestrel – 59 individuals and 53 flight lines.

Forty-nine steppe eagles (42 flight lines) is also worth noting. An overview of the VP data from the autumn migration period is presented in Table 11.6. The proportion of time spent flying within each height band is given to the nearest integer. The proportion of flight seconds in each height band within the table correspond to the amended height bands as detailed in Appendix F.

Flight lines for the target species recorded during the autumn migration period are shown in Figures TB19:1 to TB19:15 (Appendix F). All flight lines shown within the figures are assigned a unique flying bout reference, related to the KSA species codes in Appendix F which can be cross-referenced with the raw flight line data included in Appendix F. A flight activity heat map, showing the relative density of all target species flights in the autumn period is also provided in Appendix F (Figure TB19:16).

Table 11.6: Summary of all target species flight lines during the autumn survey period

Species	Flights	Flight Time (Seconds)	Total number of individual birds	Max. number of birds observed concurrently	Band A %	Band B %	Band C %	Band D %
Black kite	53	32254	119	7	21	13	51	15
Booted eagle	14	4209	17	3	1	10	67	22
Common kestrel	53	6057	59	3	39	50	11	0
Eastern imperial eagle	2	404	2	1	0	24	76	0
Egyptian vulture	6	2606	6	1	0	20	60	20
Eurasian hobby	2	115	2	1	43	57	0	0
Eurasian sparrowhawk	9	2290	13	2	21	53	26	0

Species	Flights	Flight Time (Seconds)	Total number of individual birds	Max. number of birds observed concurrently	Band A %	Band B %	Band C %	Band D %
European honey buzzard	31	97854	184	45	11	19	70	0
Hen harrier	2	286	2	1	52	0	48	0
Lesser kestrel	19	3649	27	4	37	44	19	0
Lesser-spotted eagle	3	434	3	1	0	0	100	0
Levant sparrowhawk	1	286	1	1	0	69	31	0
Long-legged buzzard	20	12127	34	5	5	10	64	21
Marsh harrier	60	20122	85	7	12	30	58	0
Montagu's harrier	24	3948	24	1	56	38	6	0
Osprey	1	342	1	1	0	0	100	0
Pallid harrier	91	10162	95	2	66	16	16	2
Purple heron	1	7733	19	19	0	0	100	0
Saker falcon	1	220	1	1	0	0	100	0
Short-toed snake eagle	1	51	1	1	0	0	100	0
Steppe buzzard	192	2122921	5235	355	4	13	64	19
Steppe eagle	42	13380	49	2	3	7	83	7
Total	**628**	**2341450**	**5979**	**-**	**-**	**-**	**-**	**-**

11.4.2.3 Constant Effort Survey Results

The constant effort surveys across the full survey period resulted in 6582 records of 68 species. The three most abundant species were steppe buzzard (1819 records), barn swallow (1231 records) and European bee-eater (1009 records). A summary of the records across the winter, spring and autumn survey periods are provided below:

Constant Effort Survey Winter and Spring Periods

The constant effort surveys in winter and spring recorded 2452 individual birds of 57 species. Ten target species were recorded during this time, three of which were not observed within active VP surveys; common crane, golden eagle and peregrine falcon. Full target species accounts are provided in Appendix F.

The most abundant species recorded during this period was barn swallow (707 records) followed by Temminck's lark (548 records). The peak day counts of birds occurred on 19 March 2017, when large mixed lark species flocks were observed, and 23 April which coincides with the peak count of barn swallow. The most notable 'secondary species' recorded was see-see partridge, which may confirm residency of this species within KSA, as such a separate account is included for this species in Appendix F. Full secondary species accounts are provided in Appendix F.

Constant Effort Survey Autumn Period

The constant effort surveys in autumn recorded 4130 individual birds of 44 species. Six target species were recording during this time all of which were also recorded during active VP surveys. Steppe buzzard was the most abundant species recorded during constant effort surveys. In total 1809 steppe buzzards were observed outside of active VP surveys with a peak day count of 1100 steppe buzzards recorded early morning on 4 October at extreme distance (>10km) whilst travelling through the site to reach a specific VP location. Full target species accounts are provided in Appendix F.

With the exception of steppe buzzard, European bee-eater was the most abundant species recorded at the development site during the autumn survey period with a total of 826 individuals observed and many heard but not directly sighted. Barn swallow (524 records), desert lark (239 records) and greater short-toed lark (110 records) make up the five species for which more than 100 records were made.

The most notable record during the autumn survey period was of a single little bustard on 8 October 2017. This is the first little bustard recorded in Saudi Arabia, as such a separate account is included for this species in Appendix F.

11.4.2.4 Species-specific Survey Results

A proportion of planned surveys and associated travel through site was undertaken near-dawn and pre-dusk, to target crepuscular and nocturnal species. A single European nightjar on 17 September 2017 was the only crepuscular or nocturnal species directly observed during the full survey period. The presence of pharaoh eagle-owl was also confirmed through other evidence (pellets) during winter surveys.

Winter surveys were undertaken in January and identified multiple species thought likely to be resident within the development site. The only species recorded during the winter survey period which was not recorded during the spring or autumn survey periods was common crane. Full target and secondary species accounts, which detail which species are considered to be resident, are provided in Appendix F.

Surveys and associated travel through the site near-dawn and pre-dusk identified target species using parts of the development site for roosting on the ground during both migration periods. This includes large numbers of steppe buzzards with smaller numbers of black kite, marsh harrier and steppe eagle also recorded on the ground, particularly during the early morning period. Further detail on roosting behavior is captured in the full target species accounts in Appendix F.

11.4.2.5 Incidental Observations

Incidental observations of birds during planned VP surveys and travel around the site have been included within constant effort survey results in Appendix F.

Nine secondary species were recorded incidentally during remote monitoring coverage for mammal activity. The most notable species, pale rockfinch was only recorded by remote trail cameras, once, on 25 April 2017 until a pair were observed directly on 16 October 2017. Full secondary species accounts to date are provided in Appendix F.

11.4.2.6 Collision Risk Modelling

The most abundant target species recorded was steppe buzzard (5271 individuals, 209 flights), which is reflected within the Collision Risk Modelling as the most ‘at risk’ species. A worst-case scenario model predicted 63.08 collisions each year at the development site, with a more refined model predicting 38.88 collisions per year. More than one hundred individuals were recorded of the following four target species (in addition to steppe buzzard): European honey buzzard (187 individuals recorded and 33 flight lines); black kite (132 individuals and 59 flight lines); marsh harrier (127 individuals and 92 flight lines); and pallid harrier (113 individuals and 109 flight lines). Steppe buzzard (see above), European honey buzzard (3.67 collisions per year), black kite (1.48 collisions per year) and steppe eagle (1.06 collisions per year) make up the four species for which worst-case scenario modelling predicted more than a single collision each year. For the remaining target species fewer than one collision per year was predicted.

Three of the target species recorded within the development site are listed as 'Endangered' by the IUCN (2017); Egyptian vulture (six individuals), saker falcon (one individual) and steppe eagle (75 individuals, including constant effort survey records). Refined collision risk modelling predicted 0.77 collisions per year for steppe eagle, which is equivalent to a collision every 1.3 years. For Egyptian vulture and saker 0.10 and 0.01 collisions per year were predicted.

11.4.3 Phase I Habitat Survey

11.4.3.1 Kingdom of Saudi Arabia Habitat Classifications

In the absence of specific Phase 1 habitat classifications for The Kingdom of Saudi Arabia, a set of interim codes has been developed for the assessment. These codes utilize Joint Nature Conservation Committee (JNCC) broad habitat classifications and habitat codes where these can be applied and more specific codes for The Kingdom of Saudi Arabia where habitat types are unique. The proposed Phase 1 habitat survey codes to be used for the Park are listed in Table 11-7. It should be noted that the JNCC Phase 1 habitat survey codes have been developed for habitats in the United Kingdom which typically support continuous vegetative communities, which aid with habitat classification. The habitats in The Kingdom of Saudi Arabia generally support more sparse vegetative communities and are often characterized by large areas of bare ground.

Table 11-7: Phase 1 Habitat Classifications for the Park

JNCC Habitat Classification	JNCC Habitat Code	Description
F. Swamp, marginal, Inundation	F2.2 Inundation Vegetation	This category includes open and innately unstable communities that are subject to periodic inundation, as found on sorted or unsorted silts, sands and gravels of wadi channels.
I. Rock Exposure	I1.1 Inland Cliff	This category is defined as rock surfaces over 2 m high and sloping at more than 60°. This applies to edges of the plateau where scour and erosion has created sheer inland cliffs.
	I1.2 Scree	Scree is defined as an accumulation, usually at the foot of a cliff, of weathered rock fragments of all sizes, mostly angular in shape. This category includes large boulder (boulder scree) which applies along sections of the plateau edge.
J. Miscellaneous	J.4 Bare Ground	Any type of bare soil or other substrate should be included within this classification. This will include consolidated sand, silts, gravels and rock coverage which support little or no vegetation and is widespread across the site plateau.

11.4.3.2 Phase 1 Habitat Survey for Development Site

The habitats within the development site can be classified into three broad habitat types, and four sub-categories. The development site is predominantly characterized by an extensive exposed desert plateau punctuated by various shallow flow routes which lead to lower lying areas and basins in the surrounding landscape.

The majority of the development site (plateau) is comprised of bare, rocky ground. These areas are comprised of two main rock types; sandstone overlain by a darker, molten-type, rock. The rock coverage varies in size and extends across the entire site in mixed densities. The molten rock is more prevalent on higher ground within the undulating site including areas of boulder outcrop on hill peaks. The lighter-colored sandstone rock is more widespread across the site and generally decreases in size until only loose gravels, silts and sand are found in the low-lying surface water flow paths.

The dominant bare, rocky ground habitat type environment only supports very sparse and sporadic coverage of *Acacia* ssp., and rarely *Anastatica hirochuntica*. These species occur in small depressions in the otherwise bare landscape where sand and aeolian sediments have accumulated allowing the sparse hardy plant communities to settle.

There is no single well defined flow path across the plateau within the developable area of the Park. The majority of flow paths on the plateau are defined as minor and the only major wadis are located on the edge of the plateau, particularly to the south and east. The flows draining from the plateau form multiple small scale localized wadis around the perimeter of the Park. These drain into more clearly defined major wadi channels off-site.

The flow paths across the site support more diverse communities, including *Citrulus colocynthis*. These areas are low energy systems and facilitate the settlement of fine silts and gravels suspended in surface water flows during seasonal rainfall events. Such events allow a wider-range of species to survive although they are uncommon in the region; anecdotal evidence suggests, on average, one or two rainfall events occur per annum. Therefore any notable areas of vegetation are largely limited to these small flow paths.

The sloping edge of the plateau varies in severity around the periphery of the site and provides the most variability in habitat type. There is little to no change in habitat to the west where the plateau extends past the boundary of the development site which is demarcated by a railway line. Along this western edge significant earthworks and likely seismic survey are evident.

Shallow sandy slopes define the edge of the plateau in north and north-west; these areas were notably preferred by mammals as indicated by multiple burrows, tracks and droppings found along this section of the development site.

A large basin lies immediately north of the plateau ranging between 100-200m below the height of the development site. Due to this sharp drop-off in height the northern edge of the plateau is characterized by large boulder scree slopes at 45º angle, or steeper, with no vegetation cover. Along some sections the plateau gives way to sheer cliff edges. Rock fall and subsidence is widely evident along the northern edge of the site.

The south, south-east and eastern edges of the plateau are less severe although scree slopes again form a large part of the plateau edge. Sheer cliffs are less common in these areas although water flow from on-site flow routes has created occasionally steep-sided ravines.

The Phase 1 habitat types and sub-categories are illustrated in Figure 11.7. Target notes are included in Appendix I. Phase 1 Habitat Photography is included in Appendix J.

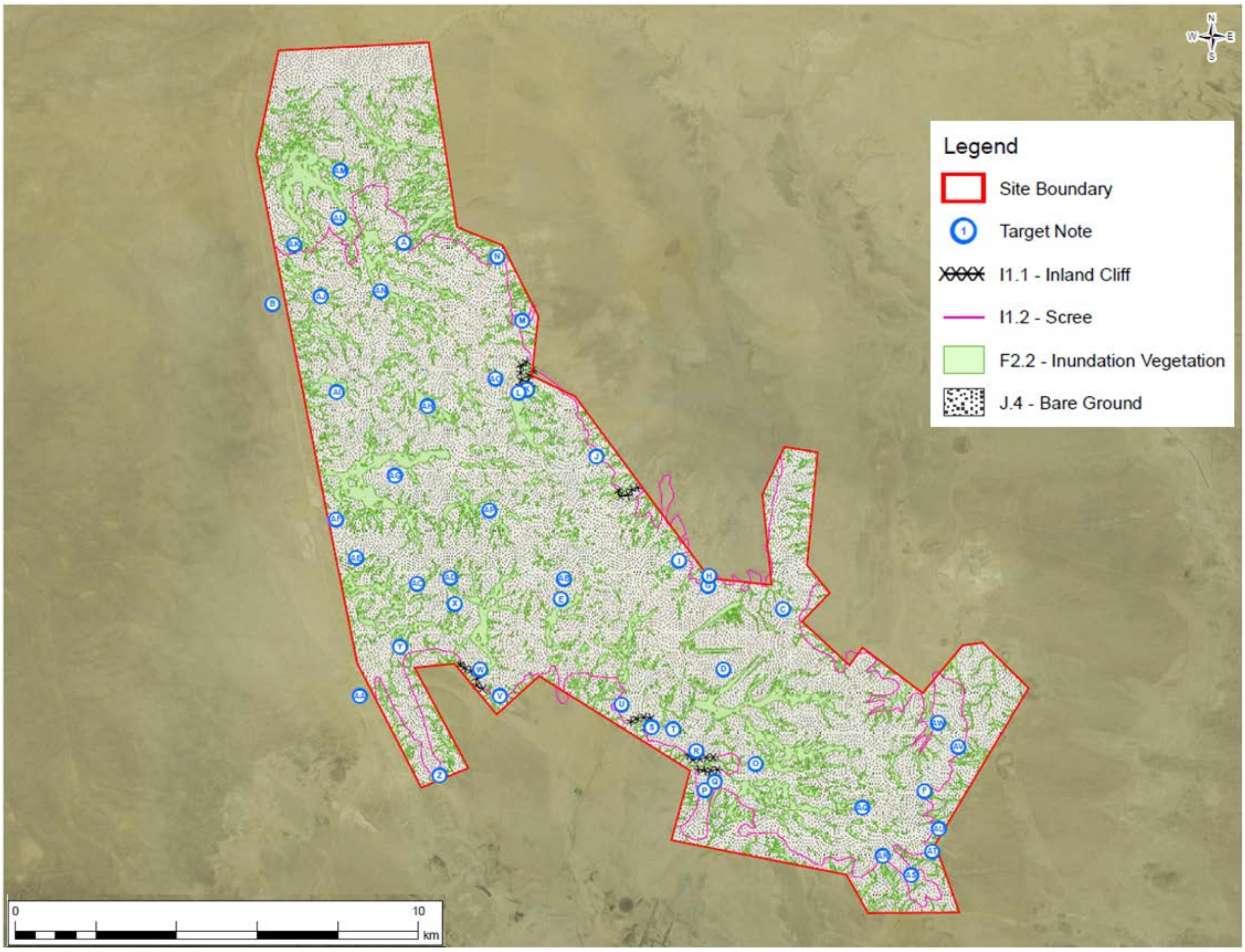

Figure 11.7: Phase I Habitat Survey

11.4.4 Floral Communities

Floral communities within the development site are most abundant and diverse within the shallow wadi channels, in particular where they converge towards the edges of the plateau to the south and east, and around the escarpment of the plateau. Communities are typically species poor, sparse and fragmented and there are no obvious community associations. The remainder of the developable area of the Park is comprised of rocky terrain which is largely devoid of vegetation.

The most dominant plant species recorded was *Achillea fragrantissima*. This species was recorded throughout the minor wadi channels within the developable area, and within the major wadi channels as they convey pluvial flows off the plateau. Acacia spp. was recorded within the wadi channels and on the escarpment slopes around the perimeter of the plateau and the boundary of the Park.

The most diverse communities were recorded in proximity to Phase 1 Habitat target note locations AC, AD, AI, AN and AO. These locations are where multiple shallow wadis converge and form major wadi channel which drains the plateau. Species recorded include *Artemisia herba-alba, Citrullus colocynthis, Plantago boissieri, Anvillea garcinii, Hyoscyamus muticus, Cleome amblyocarpa* and *Anastatica hierochuntica.*

The communities and associations recorded in proximity to the Phase 1 habitat survey target notes are listed in Table 11-8. The floral communities will be subject to further survey effort during autumn 2017.

Table 11-8: Flora Communities and Associations

Target Note	Description Floral Communities / Associations	Species List	DAFOR Scheme
D	Minor wadi area; typical of the smaller wadi systems and low-lying patches across the majority of the site. Sparse vegetation present primarily consisting of two species; *Acacia spo*. and *Achillea fragrantissima*.	*Acacia spp.* *Achillea fragrantissima* *Plantago boissieri*	O O R
H	Edge of plateau, sandy bare ground slope with rock coverage and sparse *Acacia spp.* presence.	*Acacia spp.*	O
I	Bare rock faces at the top of a vegetated (primarily *Achillea fragrantissima*) slope at the edge of the plateau. As is typical across the development site the bare ground rock coverage extends right to the edge of the plateau.	*Acacia spp.* *Achillea fragrantissima*	R O
M	A single specimen of *Anastatica hierochuntica* was recorded at this location in an otherwise barren rocky environment.	*Anastatica hierochuntica*	R
O	Typical wadi run-off area at the edge of the site plateau. Scree-slopes lining a sparsely vegetated (*Acacia sp.*) small wadi valley below.	*Acacia spp.*	R
Q	Flat area of low-lying silt/mud as part of a small and shallow wadi system on the plateau. Sparse vegetation recorded	*Achillea fragrantissima* *Plantago boissieri* *Artemisia herba-alba* *Citrullus colocynthis* *Anastatica hierochuntica*	O O R O R
S	Steep-sided ravine that cuts into the plateau. Scrubby wadi habitat sparsely covers the ravine basin. Access not possible although *Acacia* spp. dominant of the vegetation visible from distance.	*Acacia spp.*	D
T	Ravine shallows out into a wider wadi depression lined by scree; *Acacia* spp. dominant.	*Acacia spp.*	D
U	Wadi basin which cuts into the plateau edge. *Acacia* spp. most prevalent.	*Acacia spp.*	D
Y	Start of wadi run-off area; opening up to the wide wadi valley below which leads out to the farming area to the south, lying between the south-west peninsula and the main plateau. *Acacia* spp. and *Achillea*	*Acacia spp.* *Achillea fragrantissima.*	O O

Target Note	Description Floral Communities / Associations	Species List	DAFOR Scheme
	fragrantissima recorded. Primitive livestock enclosure of wood and wire nearby.		
AC	Significant wadi area; most densely vegetated area found on-site.	*Acacia spp.* *Achillea fragrantissima.* *Artemisia herba-alba* *Citrullus colocynthis* *Plantago boissieri* *Anvillea garcinii* *Anastatica hierochuntica*	O O R O O R R
AD	Low-lying sandy/vegetated wadi area.	*Achillea fragrantissima.* *Citrullus colocynthis* *Plantago boissieri* *Anvillea garcinii* *Hyoscyamus muticus* *Cleome amblyocarpa* *Anastatica hierochuntica*	A O R R R R R
AF	Small sandy wadi channel with burrow on edge of extended earthworks/seismic survey. *Acacia* spp. only vegetation recorded.	*Acacia spp.*	R
AI	Small mammal burrows recorded within small vegetated area (*Citrullus colocynthis* and *Acacia* spp.). General bare ground habitat continues from this location to the extensive earthworks along the western edge of site (railway line).	*Acacia spp.* *Citrullus colocynthis*	O F
AJ	Small mammal burrows within sandy vegetated area (*Achillea fragrantissima*). Many small prints and tracks of birds, small mammals and probable lizards.	*Achillea fragrantissima.*	A
AL	Large open wadi system extending north from the site plateau. Dense vegetation cover recorded; primarily *Achillea fragrantissima*.	*Achillea fragrantissima*	F
AN	Significant wadi/low-lying gravel area running north: *Acacia* spp. less common here but *Achillea fragrantissima* widespread.	*Acacia spp.* *Achillea fragrantissima.* *Artemisia herba-alba* *Citrullus colocynthis* *Plantago boissieri* *Anvillea garcinii* *Hyoscyamus muticus* *Cleome amblyocarpa* *Anastatica hierochuntica*	O A O O A R R R O
AO	Significant wadi area/low-lying gravel area running north to south. Signs of moisture evident in the area dominated by *Achillea fragrantissima* coverage.	*Achillea fragrantissima* *Artemisia herba-alba* *Citrullus colocynthis* *Plantago boissieri* *Anvillea garcinii* *Hyoscyamus muticus*	F R F O R R

Target Note	Description Floral Communities / Associations	Species List	DAFOR Scheme
		Cleome amblyocarpa *Anastatica hierochuntica*	R R
AQ	Short green growth in low-lying areas (*Achillea fragrantissima*) this was only recorded towards the east end of the plateau, very sporadic.	*Achillea fragrantissima.*	O
AW	Wadi running into low-lying area; *Acacia* spp. recorded. Plateau continues north seemingly all of the same bare rock type although this access was not accessed.	*Acacia spp.*	O

11.4.5 Mammals

Through a combination of Phase 1 habitat survey and the vantage point surveys for birds, the majority of the development site was accessed and sampled. Evidence of mammal activity in the form of tracks, burrows / dens, scats / droppings, hairs etc. were recorded in addition to any visual sightings. All recorded mammal activity to date is summarized in Table 11-9. Further mammal records were gathered within wider faunal surveys utilizing remote trail cameras (Section 11.4.6).

The only mammals visually recorded within the development site were camel *Camelus dromedaries*. Camels were recorded on several locations grazing freely. *Acacia spp*. appeared to be the favored grazing plant. No other live mammal specimens were visually recorded within the development site and only field signs of species were observed (i.e. burrows, dens and scats / droppings). Mammal activity was however recorded during the automated camera surveys and this is reported further in section 11.4.6.

The red fox *Vulpes vulpes* has the widest geographical range of any member of the order Carnivora, being distributed widely across the entire northern hemisphere, and has been introduced elsewhere. Red foxes are highly adaptable and opportunistic omnivores and are capable of successfully occupying a range of different ecosystems. In many habitats, foxes appear to be closely associated with people, even thriving in intensive agricultural areas. This species is classified as Least Concern by the IUCN (Hoffmann et al., 2016).

The lesser Egyptian jerboa *Jaculus jaculus* is listed as Least Concern by the IUCN because this species has a wide (albeit patchy) distribution range and a large population. Although there is significant exploitation in parts of the range, this is not currently thought to be causing population declines sufficient to trigger listing in a more threatened category (Amori et al., 2016).

Sundevalls Jird *Meriones crassus* is common and widespread and there are no known threats to its conservation status. This species is listed as Least Concern by the IUCN (Granjon, 2016).

Table 11-9: Recorded mammal activity

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Description
Camel	*Camelus dromedarius*		n/a	n/a	Evidence of camel throughout the development site.
Lesser Egyptian Jerboa *(probable)*	*Jaculus jaculus*			LC Unknown	Multiple burrows recorded on-site. Some areas likely shared with Jird spp.
Red Fox	*Vulpes vulpes arabicus*		LC Stable	LC Stable	Dead fox found. Possible dens recorded and other signs of activity (e.g. scat and prints).

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Description
Sundevall's Jird *(probable)*	*Meriones crassus*			LC Unknown	Multiple burrows associated with mature *Citrullus colocynthis* and *Acacia Sp.*

Plate 1: Red fox carcass.

Plate 2: Probable Sundevall's jird burrow.

11.4.6 Faunal Surveys Using Trail Cameras

Bushnell Trophy Cam trail cameras were deployed across the development site during winter, spring and autumn 2017. A total of 1,646 hours of recording time has been completed. A summary of the faunal activity captured by the trail cameras deployed is included in Table 11-10 and images are included in Plate 3 to 15. The locations where the trail cameras were deployed are illustrated on Figure 11.5.

A total of five mammal species (i.e. red fox *Vulpes vulpes*, desert hedgehog *Paraechinus aethiopicus*, Probable Sundevall's jird *Meriones crassus,* probable lesser Egyptian jerboa *Jaculus jaculus* and golden spiny mouse *Acomys russatus* were recorded during the trail camera surveys.

The desert hedgehog *Paraechinus aethiopicus* is listed as Least Concern by the IUCN in view of its wide distribution, presumed large population, occurrence in a number of protected areas, tolerance of a degree of habitat modification, and because it is unlikely to be declining fast enough to qualify for listing in a more threatened category (Hutterer, 2016).

The greatest number of images and video footage captured was triggered by red fox *Vulpes vulpes*. Significant fox activity was recorded at trail camera locations A, B, D, E, I, J, K and L, this species is present throughout the development site. Multiple bird species were recorded on the trail camera at location I and J next to a small drinking pool. Pale rockfinch has only been recorded during trail camera coverage (Plate 3).

Table 11-10: Trail Camera Survey Results

Trail Camera Ref	Location	Date Set	Hours Recording	Activity Recorded
A	Vegetated habitat amongst rock faces at top of scree slope.	22nd January 2017	48hrs	Numerous images and video footage of red fox, jird sp., black restart, desert lark and white-crowned wheatear.
B	Very small/sandy channel with mammal burrow.	24th January 2017	46hrs	Numerous images and video footage of red fox, jirds sp. (probable Sundevall's jird) jerboa sp. (probable Egyptian jerboa), bar-tailed lark, desert lark and hoopoe lark.
C	Multiple burrow set on hillside at north edge of plateau on the boundary of the development site.	12th March 2017	168hrs	No activity recorded.
D	Sandy channel with *Haloxylon* shrubs in a shallow flow path.	20th March 2017	72 hrs.	Red fox and desert hedgehog.
E	Scree slope at the south east edge of plateau.	27th March 2017	72hrs	Red fox.
F	Small area of boulder scree in the middle of the development site.	5th April 2017	96hrs	No activity recorded.
G	Open rocky desert in close proximity to VP6.	10th April	24hrs	No activity recorded.
H	Egyptian spiny-tailed lizard burrow amongst boulders near a track.	12th April 2017	24hrs	Egyptian spiny-tailed lizard, desert lark (pair) and hoopoe lark.
I	Small pool in a shallow flow path with many mammal and bird footprints around the muddy edges.	16th April 2017	48hrs	Red fox (two individuals) and feral pigeon (multiple).
J	A second drinking pool in close proximity to the first one which had dried up.	18th April 2017	168hrs	Red fox (at least 3 individuals) trumpeter finch (multiple) desert lark (multiple) pale rockfinch, crested lark, feral pigeons (multiple), camel spider.
K	Small rocky channel in a shallow flow path at the base of a scree slope.	27th April 2017	72hrs	Red fox, desert hedgehog, jird sp. black-eared wheatear, herd of sheep.
L	Base of a cliff in a wadi at the boundary of the development site.	1st May 2017	24hrs	Red fox and domestic dog.
M	Wadi system near edge of site plateau.	6th September 2017	140hrs	Red fox.
N	Possible fox den.	12th September 2017	120hrs	White-crowned wheatear.
O	Edge of site plateau beneath shaded overhang with signs of mammal use.	18th September 2017	144hrs	Numerous images and video of golden spiny mouse and red fox.
P	Edge of site plateau in area good for roosting raptors.	25th September 2017	140hrs	No activity recorded.

Trail Camera Ref	Location	Date Set	Hours Recording	Activity Recorded
Q	Edge of site plateau near quarry access route.	3rd October 2017	168hrs	No activity recorded.
R	Open ground near VP4	16th October 2017	72hrs	No activity recorded.

Plate 3: Deployment Location H; desert lark, Egyptian spiny-tailed lizard and hoopoe lark.

Plate 4: Deployment Location J; red fox.

Plate 5: Deployment Location J; pale rockfinch.

Plate 6: Deployment Location J; desert lark.

Plate 7: Deployment Location K; desert hedgehog.

Plate 8: Deployment Location L; red fox.

11.4.7 Reptiles

Through a combination of Phase 1 habitat survey and the ornithological surveys, the majority of the development site was accessed and sampled. Reptile sightings were recorded and are summarized in Table 11-11 and Figure 11.8. A total of seven species have been recorded throughout the developable area of the Park. The majority of records are from the southern and eastern parts of the Park, in the location of the minor flow paths and more extensive areas of vegetation.

A single Egyptian spiny tailed lizard *Uromastyx aegyptia* and active burrow was recorded within the developable area of the Park on a trail camera (Section 11.4.6). No other burrows or live specimens were recorded during the winter 2017 and spring 2017 surveys.

The Egyptian spiny tailed lizard *Uromastyx aegyptia* is listed as Vulnerable by the IUCN as there has been a suspected population decline of over 30% over the past 15 years (3 generations) and this is expected to continue into the future. The decline may be close to meeting the decline rate of 50% over three generations and population declines need to be monitored (Wilms *et al,* 2012).

The main threats to this species in Saudi Arabia are habitat loss due to over-grazing, human settlement, large-scale agricultural expansion, land reclamation, solid waste dumping and off-road vehicles. Typically its populations are very fragmented throughout its wide range. On the Arabian Peninsula, the species is still locally common in some places, especially protected areas (Wilms *et al,* 2012).

The most frequently recorded species was small-spotted lizard *Mesalina guttulata*, with 22 live specimens observed throughout the developable area of the Park. This species is not yet listed by the IUCN and there are no known threats to its conservation status.

The second most numerous species recorded was spotted toad headed agama *Phrynocephalus maculatus*, with a total of 4 specimens recorded within the southern parts of the developable area. This species is not yet listed by the IUCN and there are no known threats to its conservation status.

Two fringe fingered species were recorded during baseline surveys. A single Nidua fringe-fingered lizard *Acanthodactylus scutellatus* was recorded in proximity to ornithology survey location VP8. This species is not yet listed by the IUCN and there are no known threats to its conservation status. A single Saudi fringe-fingered lizard *Acanthodactylus gongrorhynchatus* was also recorded. This species is listed as Data Deficient in view of limited information concerning its distribution and its status within Saudi Arabia (Al Johany, 2012).

A single snake tailed fringe toed lizard *Acanthodactylus opheodurus* was recorded. This species is listed as Least Concern in view of its wide distribution, presumed large population, and because it is unlikely to be declining fast enough to qualify for listing in a more threatened category (Behbehani *et al*., 2012).

An unidentified fringe toed lizard *Acanthodactylus* spp. was recorded in proximity to ornithology survey location VP2.

Table 11-11: Reptile Summary

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status
Egyptian spiny-tailed lizard	*Uromastyx aegyptia*	1, 3	VU Decreasing	VU Decreasing
Nidua fringe-fingered lizard *(possible)*	*Acanthodactylus scutellatus*		Not Listed	Not Listed
Saudi fringe-fingered lizard	*Acanthodactylus gongrorhynchatus*	1, 2	Not Listed	Not Listed
Small-spotted lizard	*Mesalina guttulata*		Not Listed	Not Listed
Snake-tailed fringe toed lizard	*Acanthodactylus opheodurus*		LC Stable	LC Stable

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status
Spotted toad-headed agama	*Phrynocephalus maculatus*		Not Listed	Not Listed
Fringe-toed lizard sp.	*Acanthodactylus sp.*		Not Listed	Not Listed

Plate 9: Egyptian spiny-tailed lizard

Plate 10: Nidua fringe-fingered lizard (*possible*)

Plate 11: Saudi fringe-fingered lizard

Plate 12: Small-spotted lizard

Plate 13: Snake-tailed fringe toed lizard

Plate 14: Spotted toad-headed agama

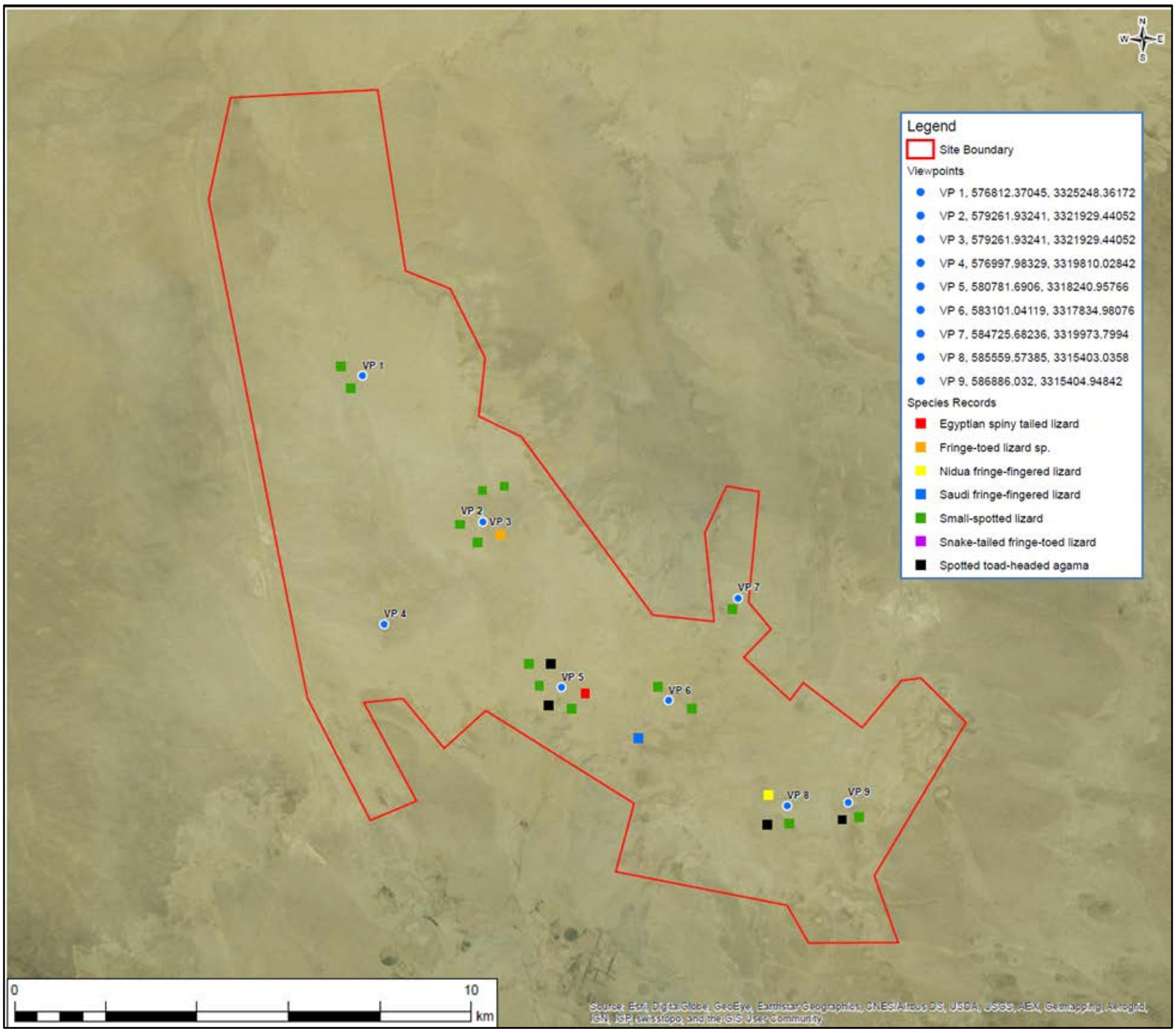

Figure 11.8: Reptile Records at the development site.

11.4.8 Invertebrates

No significant invertebrate species were recorded during the baseline surveys. Further surveys will be undertaken during the autumn 2017 surveys.

11.4.9 Bats

11.4.9.1 Assessing Need for Survey

The development site is comprised of a natural landscape with landscape-scale features that have the potential to be used by commuting and foraging bats. In particular the perimeter of the site and the edges of the plateau on which the Park will be located.

The vegetated flow paths provide potentially important corridors for bats to commute across the landscape, and are likely to harbor a greater concentration of flying and ground-dwelling insects than the adjoining areas which are predominantly comprised of bare ground. Vegetation remains sparse and fragmented, and these areas are therefore assessed as providing low to moderate quality foraging and commuting habitat.

The vertical cliffs around the perimeter of the developable area have the potential to provide roosting opportunities for bats. Opportunities for roosting are limited to natural holes and crevices which are not frequent and so the potential is assessed as low to moderate. Some of these cliffs are sloped and therefore predatory species could potentially gain access to natural holes and crevices and predate upon roosting bats.

Based on the value of the habitat, it has been assessed that there was a requirement for more detailed surveys.

11.4.9.2 Roost Surveys

There are no permanent structures within the Park which offer suitable roosting opportunities. There are natural landscape features which could be used by bats for roosting (e.g. vertical cliffs along edge of the plateau. Although not an exhaustive survey, several of these cliffs were inspected during the daytime for bat activity. The value of natural landscape features to provide roosting opportunities is assessed as low to moderate.

11.4.9.3 Bat Activity and Automated Surveys

Anabat Express automated bat detectors were deployed across the development site during spring and autumn 2017. A total of 1,420 hours of recording time using Anabat Express detectors was completed. A summary of the bat activity recorded is included in Table 11-12. The locations where the Anabat Express detectors were deployed are illustrated on Figure 11.5.

Table 11-12: Deployment locations of Anabat Express

Anabat Ref	Location	Date Set	Hours Recording	Activity Recorded
Anabat -1	Edge of plateau	06/03/2017	184	No bat activity recorded
Anabat - 2	Edge of Plateau	12/03/2017	72	Desert long-eared bat *Otonycteris hemprichii* and Sind bat *Eptesicus nastrus*
Anabat - 3	Open ground	21/03/2017	36	Sind bat *Eptesicus nastrus*
Anabat - 4	Near pools	05/04/2017	192	No bat activity recorded
Anabat - 5	Met mast	12/04/2017	144	No bat activity recorded
Anabat – 6	Open ground.	06/09/2017	144	
Anabat – 7	Edge of site plateau facing out over depression below.	12/09/2017	120	
Anabat – 8	Open ground near VP8	18/09/2017	168	
Anabat – 9	Edge of site plateau facing out over seasonally inundated pools and a cliff lined wadi.	25/09/2017	72	
Anabat – 10	Edge of site plateau in area with steeps-sided wadi valley.	01/10/2017	216	
Anabat - 11	Open ground near VP4	16/10/2017	72	

Anabat Ref	Location	Date Set	Hours Recording	Activity Recorded

A total of 646 passes from at least four species of bat were recorded, with two species identified with a high level of confidence. The overall activity rate (2.6 Bats/hour; 30.8 Bats/night) was relatively low as was the species diversity. The species recorded comprised Kuhl's pipistrelle *Pipistrellus kuhlii*, desert long-eared bat *Otonycteris hemprichii*, Sind bat *Eptesicus nasutus* and/or Botta's serotine *Eptesicus bottae*, and a *Molossidae* species of bat, most likely to be Egyptian free-tailed bat *Tadarida aegyptiaca*.

Across the survey season, the species with the highest relative activity rate recorded was Kuhl's pipistrelle, at an average of 25.1 B/n (B = 528; 81.7 % of total activity) followed by desert long-eared bat (B = 81; 3.9 B/n; 12.5 % of total) and Sind bat/Botta's serotine (B = 17;0.8 B/n; 2.6 % of total) with just one pass recorded from a *Tadarida* species of bat. A further 19 passes were classified as unidentified bat calls.

Overall bat activity was low in Spring with just five bat passes recorded: two passes from desert long-eared bat, and three from Sind bat/Botta's serotine. All the remaining bat passes were recorded in Autumn.

Bat activity was generally low at all locations except Autumn 2, where the large majority of the bat passes were recorded (B = 501; 102 B/n; 94.7 % of total). This total included relatively high levels of activity from all of the three most commonly occurring species/species groups recorded on the site – Kuhl's pipistrelle, desert long eared bat and Sind bat/Botta's serotine. Only 34 bat passes were recorded across all other locations during spring and autumn. This indicates that bat activity may be sporadic and very isolated in the desert environment, and is likely to occur in areas where prey congregates. Autumn 2 was located on the edge of the plateau in the east of the site. There was no clear reason why such high levels of activity were recorded at this location, although it is possible that the plateau edge at this location created structural diversity and a greater diversity of micro-habitats suitable to support a greater diversity and density of invertebrate prey.

Nocturnal activity patterns showed that most passes were recorded outside of the two hours following sunset and two hours preceding sunrise, with 538 passes (83.3 % of total) occurring during this period. The average night length (between sunset and sunrise) was 11-12 hours and the four hours closest to sunset and sunrise comprised approximately one third of the average night length. This implies that either bats occurring at these times were not roosting nearby and it took some time for them to reach the site from their roosts; or that the site was of secondary importance for foraging, and was not the first or last area that bats foraged in after leaving, or before returning to their roosts. This general pattern was true of Kuhl's pipistrelle (85.2 %) and Sind bat/Botta's serotine (82.4 %) but less pronounced for desert long-eared bat (69.1 %) with the records of the latter being spread fairly evenly through the night. It is notable, however, that there were a reasonable number of records of bats within an hour of sunset or sunrise. This may indicate that at least some bats could have been roosting in proximity to the site. The timing of records is summarised below.

- *Kuhl's pipistrelle* - There were seven records of Kuhl's pipistrelle between 25 and 41 minutes of sunset during 12-16 September at Autumn 2. The only other early record was from Autumn 4 on 25 September at 36 minutes after sunset. All records of this species within an hour of sunrise (B = 24) were from Autumn 2 with the latest record being 36 minutes before sunrise.
- *Desert long-eared bat* - There were nine records of this species within an hour of sunset at Autumn 2, with the earliest being 35 minutes after sunset. Just one sound file attributed to this species was recorded within an hour of sunrise with the latest record being 53 minutes before sunrise.
- *Sind bat/Botta's serotine* – Two records of this species group were recorded within an hour of sunset, both of which were recorded at Spring 1 on 10 April, and may have involved the same bat. Another notable record from Spring 1 was at 77 minutes after sunset on 29 March. All other records (B = 14) were from Autumn 2 and outside the four hours closest to sunset and sunrise.

The surveys identified relatively low levels of bat activity from four species of bat with the two most frequently recorded species, Kuhl's pipistrelle and desert long-eared bat identified with a high level of confidence. An *Eptesicus* species, likely to be Sind bat or Botta's serotine (or both) was also recorded, as well as a single pass of a *Molossidae* species of bat most likely to be Egyptian free-tailed bat *Tadarida aegyptiaca*.

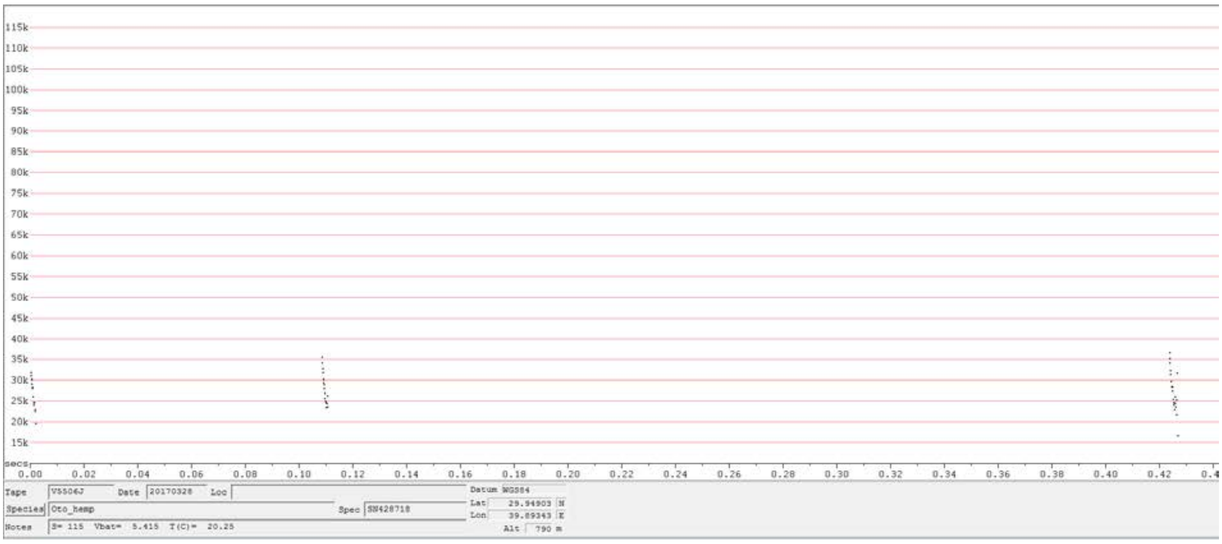

Figure 11.9 : Desert Long Eared Bat Sonogram (F7 view uncompressed)

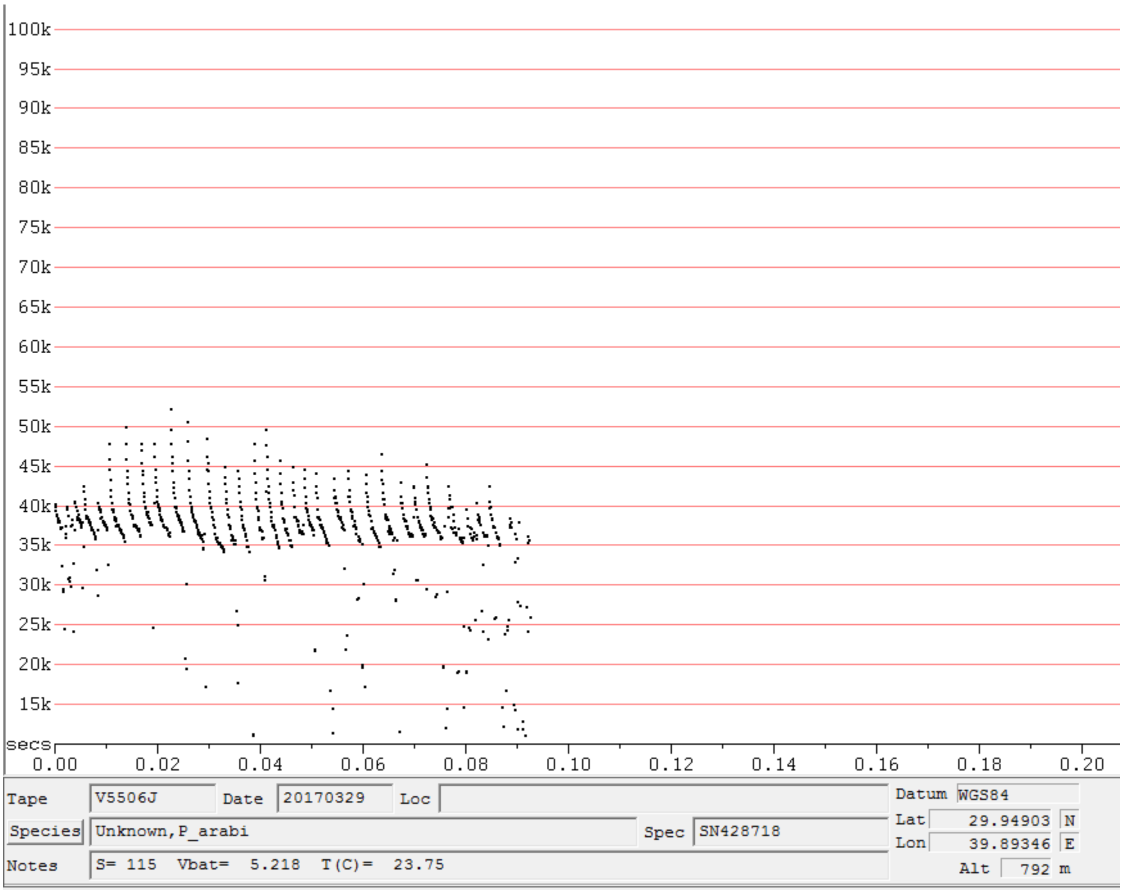

Figure 11.10 : Sind bat sonogram (F7 view compressed)

11.5 Ecosystem Services

The developable area of the Park does not support any major wadi channels or fluvial flow routes through the site. The developable area does however support minor flow paths which form multiple small scale localized wadis around the perimeter of the plateau. Major flow paths are located on the edge of the plateau and drain the plateau to the surrounding land beyond the boundary of the Park.

Typically, this ecosystem service would be classified as a **Regulating Service** which is the benefit people obtain from the regulation of ecosystem processes, in this instance the management of flood risk. The communities to the south of the Park are likely to benefit from the permeable nature of the site and natural infiltration of pluvial flows thereby reducing natural run-off from the plateau.

There is evidence that the site is used recreationally by the local community, with low numbers of off-road vehicles observed accessing the site during the weekends. Furthermore, informal gardens have been established in several locations which comprise of a post and wire fence and several planted containers. This use of the site is considered to be included within **Cultural Services** which are the non-material benefits people obtain from ecosystems (e.g. natural areas that are sacred sites and areas of importance for recreation and aesthetic enjoyment). The recreational use of the site is assessed to be low, based on the observations recorded during the spring bird surveys during which surveyors were on site between March and May. It should be noted that access to this site is unauthorized and no approval has been sought for the informal gardens which have been established. No hunting has been observed within or adjacent to the developable area of the Park.

Camel grazing was recorded across the site, although camels were only ever observed in small numbers. There was no evidence of transient or semi-permanent animal husbandry operations (i.e. tents, livestock enclosures) within or adjacent to the developable area. The suitability of vegetative communities for livestock grazing offered by the site is classified as a **Provisioning Service** which includes the products people obtain from ecosystems. The value of this service is considered to be low based on the scarcity of vegetative growth across the developable area. There is no indication that grazing is undertaken by indigenous Bedouin which would be considered as Indigenous Peoples under IFC Performance Standard 7.

11.6 Ecological Impact Assessment Methodology

The assessment of ecological impact has utilized UK best practice Guideline for Ecological Impact Assessment as published by the Chartered Institute of Ecology and Environmental Management (2016). In accordance with these guidelines the approach in determining significance of impacts takes into account the value of an ecological receptor at geographical scale, and the geographical scale at which the impact is assessed as significant.

This approach includes the following key stages:

- identification and evaluation (at a geographical scale) of ecological resources and features likely to be affected;
- identification of the biophysical changes likely to affect valued ecological resources and features; and,
- assessment of whether these biophysical changes are likely to give rise to a significant ecological impact, defined as an impact on the integrity of a defined site or ecosystem and/or the conservation status of habitats or species within a given geographical scale, including cumulative impacts.

This differs from the assessment of impact significance in other areas of environmental impact assessment, where significance would be a function of receptor sensitivity and impact magnitude. For ecology, these aspects are independent.

11.6.1 Determination of Significance

11.6.1.1 Receptor Value (Sensitivity)

Within the Kingdom of Saudi Arabia, there is limited legislation which affords species with legal protection and there is also limited data on the conservation status and population trends of individual species. Therefore the value, or potential value, of each biological resource has been developed using the following source documents:

- the list of species of High Conservation Priority as prepared by the former National Commission for Wildlife Conservation & Development(undated), now the Saudi Wildlife Authority, in response to the ratification of the U.N. Convention on Biological Diversity (1993); and,
- the International Union for the Conservation of Nature (IUCN) Red List 2012.

The species of High Conservation Priority are assigned a value in accordance with the following categories, and species may fall within one or more categories:

i. Genera, species, or subspecies that are critically endangered, endangered, or vulnerable (globally, regionally, or nationally); taxa which are locally extinct in the wild may be included, provided that there is an SWA policy to reintroduce them.

ii. Genera, species, or subspecies endemic to the Arabian Peninsula, the Red Sea, or the Gulf.

iii. Genera, species, or subspecies of which the conservation of populations within Saudi Arabia is essential to the conservation of the taxon (e.g. near-endemics and migrants for which Saudi Arabia represents a critical range).

iv. Relict genera, species, or subspecies that are of global, regional, or national significance.

v. Genera or species of special ecological importance (i.e. fulfilling a vitally important function in an ecosystem such as providing a key habitat for other species, serving as indicator species, etc.).

vi. Genera of species of significant economic importance.

vii. Genera or species that serve a “flagship” function (i.e. high-profile species of cultural value, the protection of which will also protect large numbers of other species that share their habitats).

The IUCN Red List categorizes species into nine groups based on their risk of global extinction, set through criteria such as rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation (Figure 11.11). The nine categories are:

- Extinct (EX) – No known individuals remaining.
- Extinct in the Wild (EW) – Known only to survive in captivity, or as a naturalized population outside its historic range.
- Critically Endangered (CR) – Extremely high risk of extinction in the wild.
- Endangered (EN) – High risk of extinction in the wild.
- Vulnerable (VU) – High risk of endangerment in the wild.
- Near Threatened (NT) – Likely to become endangered in the near future.
- Least Concern (LC) – Lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category.
- Data Deficient (DD) – Not enough data to make an assessment of its risk of extinction.
- Not Evaluated (NE) – Has not yet been evaluated against the criteria.

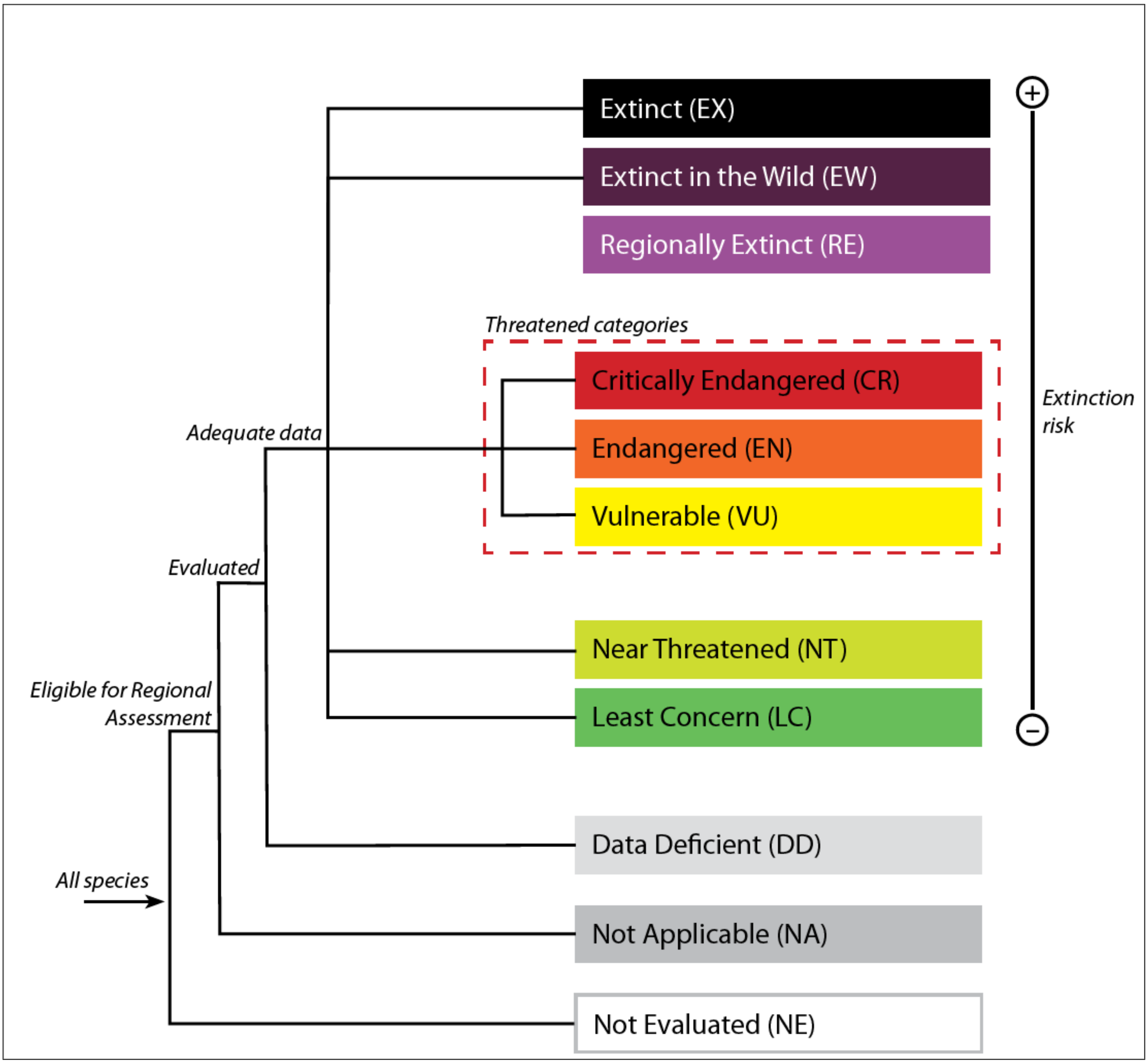

Figure 11.11: IUCN Classification System

Using the list of species of High Conservation Priority and the IUCN Red List, a geographical frame of reference has been developed to assign value (Table 11-13). To fully acknowledge the spatial range associated with some biological resources (e.g. migratory birds) and potential impacts outside national boundaries, a "very high" level of significance will be considered where appropriate.

Table 11-13: IUCN Classification System

Value / Importance	Criteria
International	Internationally designated sites or habitats. Nationally significant populations of globally threatened or endangered species (e.g., IUCN Vulnerable or Endangered Red Data Book species). Sites supporting >1% of a bio-geographical population of a species or subspecies.
National	Nationally designated or protected sites. Best examples of habitat within the country (e.g., the largest area of a particular habitat, a good example of a threatened or declining habitat).

	Strong populations of rare or nationally threatened species (e.g., a species occurring in less than 1% of the land surface of the country).
Regional	Sites or habitats internationally recognized but not necessarily designated or protected (e.g., Important Bird Areas). Strong populations of endemic or near-endemic species or subspecies to the Arabian Peninsula. Extensive areas of semi-natural vegetation or habitats characteristic of the Arabian Peninsula.
Provincial	Areas of habitat considered to enrich the habitat resource within 50 km of the site or within a defined geographic area of the country. Provincially designated or protected sites. Sustainable or strong populations of nationally scarce species (would be defined according to the size of the country and information available, e.g., species occurring in less than 5% of the land surface of the country).
Local	Areas of semi-natural vegetation or habitat considered to appreciably enrich the habitat resource within the context of the site and surrounding area. Sustainable populations of uncommon or declining species.
Site	Sites that retain habitats and/or species of limited ecological importance owing to their size, species composition or other factors.

The IUCN Red List of species is founded on a scientific understanding of the population status and trends of species. The value of utilizing the list of species of High Conservation Priority is that the cultural and economic value of species is recognized and assigned a value of importance.

11.6.1.2 Impact Magnitude

For the purposes of this assessment, the impact descriptors in Table 11-14 are taken to summarize the overall magnitude of positive or negative impacts in accordance with the guidance produced by the Chartered Institute of Ecology and Environmental Management (CIEEM, 2016), including:

- Impact extent/scale (e.g. entire habitat loss, partial habitat loss or indication over specific area affected);
- Direct or indirect impact (e.g. direct mortality of individuals due to construction activities, or indirect mortality of individuals from reduced prey resources due to land use change);
- Reversibility of impact (reversible or irreversible);
- Frequency of impact (single event, recurring or constant);
- Duration of impact (short-term, medium-term, long-term or permanent); and
- Likelihood of occurrence (certain/near certain, probable, unlikely or extremely unlikely).

The magnitude of impacts is defined using the criteria set out in Table 11-14. Impact magnitude was identified as high, moderate, low or negligible, following the above impact characterization approach.

Table 11-14: Impact Descriptors and Characterization for Ecological Features

Impact Descriptor	Impact Magnitude / Characterization
High	An impact resulting in a permanent effect on the distribution and/or abundance of a habitat, species assemblage/community or population, in such a way as to alter the integrity of the feature and its conservation status. If negative, this type of effect would reduce the integrity of the feature and its conservation status. If positive, it would result in an improvement to the conservation status of the feature.
Moderate	An impact resulting in a long-term but reversible effect on the distribution and/or abundance of a habitat, species assemblage/community or population. If negative, this type of effect would have neutral long-term implications for the integrity of the feature or its conservation status. If positive, it would not alter the long-term conservation status of the feature.
Low	An impact resulting in a short-term reversible effect on the distribution and/or abundance of a habitat, species assemblage/community or population.
Negligible	No discernible impact on the distribution and/or abundance of a habitat, species assemblage/community or population.

11.6.2 Evaluation of Significance

In accordance with CIEEM (2016), a significant impact is an impact (negative or positive) on the integrity of a defined site or ecosystem and/or on the conservation status of habitats and species. Significance of impacts is also determined by taking cognizance of the list of species of High Conservation Priority and IUCN Classifications.

The above magnitude and importance information is taken together and applied to a matrix to determine the significance of an impact (Table 11-15). Impacts can be adverse or beneficial, either decreasing or improving the health, ecological status or viability of a population, species or habitat.

Only impacts on important ecological features (provincial importance or above) are usually progressed through the detailed assessment process. For example, a small area of featureless desert would be evaluated as of less than provincial ecological importance, and would not progress through the assessment process as this only includes features of local importance or below. However, any impact on an IUCN protected area or Important Bird Area (IBA), would progress through the assessment process as such sites are designated as nationally and internationally important. In this instance, for the Dumat wind energy park impacts on ecological features at the site level have been considered to ensure best practice mitigation recommendations are documented.

Mitigation may, however, be required to be developed prior to construction to ensure that ecological features are avoided, regardless of feature importance or significance of impact, where practicable (e.g., damage to small mammal burrows).

Where impacts are assessed as being Major or Moderate these were considered to be potentially significant under the terms of EIA, and would require further assessment and development of mitigation to reduce impacts where feasible.

Table 11-15: Impact Significance

Magnitude / Importance	High	Moderate	Low
International	Major	Major	Moderate
National	Major	Moderate	Moderate
Regional	Major	Moderate	Minor

Magnitude / Importance	High	Moderate	Low
Provincial	Moderate	Minor	Negligible
N.B. Major = High, Minor = Low			

The impact significance terms are detailed in Table 11-16 and take account of Species of High Conservation Priority (1993), IUCN Classifications (2016) and CIEEM guidance (2016).

Table 11-16: Description of Significance Categories

Significance Category	Typical Description
Major	Associated with features of international, national or regional importance. Likely to be a damaging impact or loss of integrity. Effects likely to be permanent and irreversible resulting in a loss of structure and/or function. If beneficial, they will have a significant positive effect on the international or national feature.
Moderate	Associated with features of international, national, regional or provincial area importance. Likely to be a damaging impact or loss of integrity. Effects are likely to be long term but reversible. If beneficial, they will have a significant positive effect on the international or national feature.
Minor	Associated with features of regional, or provincial area importance. Likely to be a damaging impact or loss of integrity. Effects are likely to be short term and reversible. If beneficial, they will have a significant positive effect on the international or national feature.
Negligible	No significant effects.

11.6.3 Construction, Operational and Decommissioning Impacts

To aid consistency of the ecological impact assessment, a standard list of potential adverse impacts for the Park has been developed for the construction, patio and decommissioning phases of the Park. These impacts are described as:

- Habitat loss;
- Habitat degradation;
- Habitat fragmentation;
- Direct mortality / injury;
- Disturbance; and,
- Pollution.

Potential impacts for the construction phase of the Project are listed in Table 11-17, and potential operation phase impacts are listed in Table 11-18. When determining the significance of impact for each ecological resource (e.g. habitats, mammals, birds and reptiles), the species of highest 'value' and sensitivity has determined the impact assessment outcome.

Table 11-17: Predicted Construction Impacts

Impact	Source
Habitat loss	Site clearance, grading and excavation and cut and fill operations to prepare development areas. Construction of wind turbine generators. Construction of temporary and permanent access/haul routes and crane lifting pads.

Impact	Source
	Establishment of construction workforce accommodation camps and office facilities. Establishment of material storage areas. Installation of utilities. Installation of temporary and permanent fencing. Stockpiling of overburden from cut and fill operations.
Habitat degradation	Site clearance, grading and excavation and cut and fill operations to prepare development areas. Construction of wind turbine generators. Smothering and compaction of habitat from storage of overburden arising from cut and fill operations and access/haul routes. Changes to hydrological functionality of flow paths and the pattern of surface water flows (i.e. erosion and deposition). Increased use of natural environment by construction workforce. See impacts under pollution
Habitat fragmentation	Construction of wind turbine generators and development of the Park. Construction of temporary and permanent access/haul routes. Installation of utilities. Installation of temporary and permanent fencing.
Direct mortality / injury of species	Site clearance, grading and excavation and cut and fill operations to prepare development areas. Construction of temporary and permanent access/haul routes. Establishment of construction workforce accommodation camps and office facilities. Establishment of material storage areas. Installation of utilities. Installation of temporary and permanent fencing. Stockpiling of overburden from cut and fill operations. Movement of construction vehicles.
Disturbance	Noise/vibration during construction. Movement of construction vehicles. Light pollution during construction.
Pollution	Noise and dust emissions. Run-off from disturbed ground. Spillage of oils/chemicals.

Table 11-18: Predicted Operational Impacts

Impact	Source
Habitat loss	No further impacts predicted.
Habitat degradation	Changes to hydrological functionality of flow paths and the pattern of surface water flows (i.e. erosion and deposition). Increased use of natural environment by operational workforce. See impacts under pollution
Habitat fragmentation	Permanent presence of significant infrastructure, primarily the wind turbine generators.

Impact	Source
Direct mortality / injury of species	Bird and bat collision risk with wind turbine generators.
Disturbance	Increased movement of people and vehicles within the Park during routine maintenance and security inspections.
Pollution	Accidental leaks / spills (e.g. from transformers).

11.7 Impact Assessment

11.7.1 Overview

The assessment of impact considers mitigation and enhancement measures that have been developed and implemented during the design of the Park. This is in compliance with the best practice guidelines and the guidelines for ecological impact assessment published by IEEM (2016). The integration of mitigation and enhancement measures during the design phase of the Park facilitate the avoidance of impacts, and contribute towards reducing the magnitude of those impacts which cannot be avoided.

The assessment of impact therefore considers the potential residual impacts following the implementation of the design measures.

11.7.1.1 Mitigation through Wind Farm Design

The design of the Park and the configuration of the wind turbine generators have been influenced by the existing landscape and the flow routes within the developable area. Although the primary driver for current design of the Park is the potential for fluvial and pluvial impacts of flooding, the measures implemented will contribute towards avoiding and minimizing potential impacts on ecological receptors. The measures implemented during the design phase that will be implemented include:

- The flood risk assessment identified that the majority of the wind turbine locations fall into the 'very low' risk of flooding. Six turbines fall into the 'low' risk of flooding and it has been recommended that these turbines are relocation. The positioning of the wind turbines out of the flow paths within the developable area of the Park will avoid impacts on the floral and faunal communities associated with these landscape features.
- Further to the flood risk assessment, wind turbines have been removed from the northern part of the developable area of the Park. This location acts as a 'sink' during periods of rainfall and surface water flows collect in this location.
- Further to flood risk assessment it is recommended that the Park access roads and internal road network are rerouted to avoid areas which have been identified as susceptible to flood risk and erosion. This aspect of the design avoids impacts on the floral and faunal communities associated with these landscape features.
- In general bat activity tends to concentrate at linear landscape and habitat features where habitats are more complex, micro-climatic conditions more stable and the density of prey species is likely to be higher. Natural England interim guidance document *Bats and Onshore Wind Turbines Interim Guidance (Technical Information Note TIN051)*(2009) suggests that the risk of bat collision can be minimized by locating turbines so that the blade tip is at least 50m from the nearest 'bat friendly' feature at its closest point. The turbines will be set back from the edge of the plateau to safeguard against future risk of scour and erosion of the plateau edge. This will directly benefit bats and minimize the potential risk of collision with the turbines.
- All medium-voltage and communication cabling (i.e. fiber optics) connecting the wind turbine generators to the sub-stations are assumed to be underground, (however, it is noted that depending on the final design, there is a potential to use over head lines) thereby contributing towards a reduced risk of bird / bat collisions with infrastructure.

11.7.1.2 Micro-siting of wind turbine generators

- During the detailed design of the Park, the IPP will review the micro-siting of the wind turbine generators to achieve a minimum stand-off distance of 70m from blade tip to the edge of the plateau.

11.7.1.3 Mitigation measures during construction

- Where there is a requirement to remove vegetation, this should preferably be undertaken during the winter months when there is less risk of impacting on nesting birds and when other faunal populations which are dependent on these resources are less active. If there is a requirement to remove vegetation during the spring or autumn periods, a competent ecological professional should first complete breeding bird checks. If evidence of breeding bird activity is recorded, clearance should be postponed for up to 21 days or as soon as the young have fledged.
- Pre-construction surveys for the Egyptian spiny tailed lizard will be undertaken prior to the construction of internal roads, crane lifting pads and the construction of wind turbine generator foundations. If burrows are recorded within the construction footprint, a program of trapping and translocation will be implemented.

11.7.2 Baseline Survey Evaluation

Prior to undertaking the impact assessment, the conservation status of ecological features recorded during baseline surveys must first be confirmed. The conservation status of recorded ecological features, excluding migratory and resident birds, is provided in Table 11-19, along with a short justification for the assigned conservation importance of each feature. The evaluations take into account baseline conditions and utilize the criteria in Table 11-13 to develop an understanding of the implications for features that may be affected by the proposed development.

The evaluation of importance of migratory and resident birds is provided in Table 11-20. Full details of the baseline surveys methods, collision risk modelling and results are provided in Appendix F. Collision risk modelling results presented are based upon a number of precautionary assumptions for bird impacts in relation to the development.

There is limited information available on the sizes of the sub-populations of target species birds recorded within the development site. It is assumed that migrant birds using the East Asian/East African Flyway recorded passing through the site may come from a wide geographic area, and that the overall (reference) populations within these areas are potentially large. The estimated global and European populations of each species have been discussed, where available, although due to the overall lack of available information the assessment is based on the records gathered at the development site and cannot easily be compared to the reference populations.

Table 11-19: Conservation Status, Baseline and Evaluation of Terrestrial Features

Ecological Feature	Conservation Status	Evaluation	Importance
Protected Areas	National Designation	Dawmat al Jandl IBA is located approximately 13km to the south of the Park.	National
Habitats	No formal classification	The habitats within the development site can be classified into three broad habitat types, and five sub-categories. These habitats are common within the Kingdom of Saudi Arabia and the Red Sea coastal region.	Site
Floral Communities	No formal classification	Floral communities are typical of the Kingdom of Saudi Arabia and no endemic species were recorded.	Site
Mammal species	IUCN Least Concern	A total of four non-domesticated mammal species were recorded within the developable area during baseline surveys. These species are all listed as Least Concern.	Site

Ecological Feature	Conservation Status	Evaluation	Importance
Bat species	IUCN: Least Concern	Four confirmed bat species were recorded within the developable area during baseline surveys. An *Eptesicus* species, likely to be Sind bat or Botta's serotine (or both) was also recorded, as well as a single pass of a *Molossidae* species of bat most likely to be Egyptian free-tailed bat *Tadarida aegyptiaca*. The overall activity rate was recorded as 2.6 Bats/hour; 30.8 Bats/night. Recorded activity was relatively as was species diversity.	Site
Reptile species	IUCN: Least Concern, Vulnerable decreasing.	A total of seven reptile species were recorded during baseline surveys. *Uromastyx aegyptia* was only recorded once. This species is listed as Vulnerable by the IUCN. Although there is no national legislation affording protection to this species, it is listed as a species of High Conservation Priority. All other species are listed as Least Concern.	Regional
Invertebrate species	Not yet classified by IUCN	Invertebrate communities are typical of the Kingdom of Saudi Arabia and no endemic species were recorded.	Site

Table 11-20: Conservation Status, Baseline and Evaluation of Migratory and Resident Bird Species

Ecological Feature	Conservation Status	Baseline	Evaluation	Importance
Black kite	Least Concern	Across the full survey period 135 black kites were recorded within the development site. Collison risk modelling predicted 1.48 collisions per year, which is the equivalent of a collision every 0.68 years. Refined collision risk modelling for black kite predicted 0.85 collisions per year, which is the equivalent of a collision every 1.18 years.	The global population size of black kite is estimated between 1.4 and 2 million mature birds and is considered to be one of the most common raptors in the world (BirdLife International, 2016). The actual global population size and current population trend are unknown, owing to its abundance across the world.	Local
Booted eagle	Least Concern	Seventeen booted eagle were recorded during the autumn survey period within the development site. Collison risk modelling predicted 0.17 collisions per year, which is the equivalent of a collision every 5.88 years.	The European population size of booted eagle is estimated between 23,100-29,100 pairs, which equates to 46,300-58,300 mature individuals (BirdLife International, 2015). Europe forms approximately 31 % of the global range, so a very preliminary estimate of the global population size is 149,000-188,000 mature individuals (BirdLife international, 2016).	Site
Common crane	Least Concern	Three common cranes were recorded together within the development site during the winter survey period. Collision risk modelling was not undertaken for common crane as the	The European population size of common crane is estimated at 113,000-185,000 pairs, which equates to 225,000-370,000 mature individuals (BirdLife International, 2015). The	Site

Ecological Feature	Conservation Status	Baseline	Evaluation	Importance
		birds were recorded below collision risk height.	global population is estimated to number between 491,000-503,000 individuals (Wetlands International 2015). The population size of common crane is increasing (Birdlife International, 2016).	
Common kestrel	Least Concern	A total of 85 records of common kestrel were noted within the development site across the full survey period. Common kestrel is considered to be the only target species that is semi-resident within the development site although it is also a passage migrant. Collison risk modelling predicted 0.16 collisions per year, which is the equivalent of a collision every 6.25 years.	The European population size of common kestrel is estimated at 409,000-603,000 pairs, which equates to 819,000-1,210,000 mature individuals (BirdLife International, 2015). Europe forms approximately 19 % of the global range, so a very preliminary estimate of the global population size is 4,310,000-6,370,000 mature individuals (Birdlife International, 2016). The population size of common kestrel is decreasing (Birdlife International, 2016).	Site
Eastern imperial eagle	Vulnerable	Two juvenile Eastern imperial eagle were recorded within the development site in the autumn survey period. Collison risk modelling predicted 0.02 collisions per year, which is the equivalent of a collision every 50 years.	The European population is estimated to number 1,300-1,900 breeding pairs, equating to 2,500-3,800 mature individuals. Recent population estimates in Russia and Kazakhstan suggest the global population may exceed 10,000 mature individuals although these estimates have been criticised and a precautionary population banding of 2,500 to 9,999 mature individuals in outlined by BirdLife International (2016). The European population is thought to be increasing (BirdLife International, 2015) although populations in Russia and Kazakhstan are under threat due to human pressures, such as deforestation, on breeding sites. The population size of eastern imperial eagle is therefore considered to be decreasing overall (Birdlife International, 2016).	Local
Egyptian vulture	Endangered	Six Egyptian vulture were recorded within the development site during the autumn survey period. Collison risk modelling predicted 0.10 collisions per year, which is the equivalent of a collision every 10 years.	The European breeding population of Egyptian vulture is estimated at 3,000-4,700 pairs, equating to 6,000-9,400 mature individuals (BirdLife International, 2015). Europe forms 25-49 % of the global range, so a very preliminary estimate of the global population size is 18,000-57,000 individuals (BirdLife International, 2016). The global population size of Egyptian vulture is decreasing (BirdLife	Local

Ecological Feature	Conservation Status	Baseline	Evaluation	Importance
			International, 2016) as is the resident Arabian population (Jennings, 2010).	
Eurasian hobby	Least Concern	Two adult Eurasian hobby were recorded separately within the development site in the autumn survey period. As Eurasian hobby were only recorded flying below collision risk height there are no collisions predicted.	The European population of Eurasian hobby is estimated at 92,100-147,000 pairs, which equates to 184,000-295,000 mature individuals (BirdLife International, 2015). Europe forms approximately 30 % of the global range, so a very preliminary estimate of the global population size is 613,000-983,000 mature individuals (BirdLife International, 2016). The population size of Eurasian hobby is decreasing (BirdLife International 2016).	Site
Eurasian sparrowhawk	Least Concern	Fourteen Eurasian sparrowhawk were recorded within the development site across the full survey period. Collison risk modelling predicted 0.06 collisions per year, which is the equivalent of a collision every 18.18 years.	The European population of Eurasian sparrowhawk is estimated at 403,000-582,000 pairs, which equates to 805,000-1,160,000 mature individuals (BirdLife International, 2015). Europe forms approximately 36 % of the global range, so a very preliminary estimate of the global population size is 2,240,000-3,220,000 mature individuals (BirdLife International, 2016). The population size of Eurasian sparrowhawk is stable (BirdLife International, 2016).	Site
European honey buzzard	Least Concern	A total of 187 European honey buzzard were recorded within the development site across the full survey period. Collison risk modelling predicted 3.67 collisions per year, which is the equivalent of a collision every 0.27 years. Refined collision risk modelling for European honey buzzard predicted 2.04 collisions per year, which is the equivalent of a collision every 0.49 years.	In Europe, the breeding population of European honey buzzard is estimated at 118,000-171,000 breeding pairs, equating to 235,000-342,000 mature individuals (BirdLife International, 2015). Europe forms approximately 82 % of the global range, so a very preliminary estimate of the global population size is 287,000-417,000 mature individuals (BirdLife International, 2016). The population size of European honey buzzard is decreasing (BirdLife International 2016). A large proportion of the global population of European honey buzzard utilise the Rea Sea/Rift Valley flyway. This includes conservative estimates of > 60 % of the European population passing through the migration bottleneck Eilat, over 400km west of the development site. A total of 101,854 European honey buzzards were recorded during the spring migration period of 2017 and a total of 195,996 were recorded there during the spring	Local

Ecological Feature	Conservation Status	Baseline	Evaluation	Importance
			migration period of 2016 (Trektellen, 2017).	
Golden eagle	Least Concern	A single golden eagle was recorded on the edge of the development site in the spring survey period. Collision risk modelling was not undertaken for golden eagle as the individual was not recorded during VP surveys.	The European population is estimated at 9,300-12,300 pairs, which equates to 18,500-24,500 mature individuals (BirdLife International 2015). Europe forms approximately 16 % of the global range, so a very preliminary estimate of the global population size is 116,00-153,000 mature individuals (BirdLife International, 2016). The population size of golden eagle is stable (BirdLife International, 2016).	Site
Griffon vulture	Least Concern	Eight griffon vultures were recorded concurrently with the development site in the spring survey period. Collison risk modelling predicted 0.43 collisions per year, which is the equivalent of a collision every 2.33 years.	The European population is estimated at 32,400-34,400 pairs, which equates to 64,800-68,800 mature individuals (BirdLife International 2015). Approximately 10 % of the global range for this species is within Europe, so a very preliminary estimate of the global population size is 648,000-688,000 mature individuals. The population size of griffon vulture is increasing (BirdLife International, 2016).	Site
Hen harrier	Least Concern	Eight hen harriers were recorded within the development site across the full survey period. Collison risk modelling predicted collisions 0.04 per year, which is the equivalent of a collision every 20 years.	The European population of hen harrier is estimated at 30,000-54,400 breeding females, which equates to 60,000-109,000 mature individuals (BirdLife International, 2015). Europe forms approximately 34 % of the global range, so a very preliminary estimate of the global population size is 176,000-321,000 mature individuals (BirdLife International, 2016). The population size of hen harrier is decreasing (Birdlife International, 2016).	Site
Lesser kestrel	Least Concern	Twenty-nine lesser kestrels were recorded within the development site across the full survey period. Collison risk modelling predicted 0.11 collisions per year, which is the equivalent of a collision every 9.09 years.	The European population of lesser kestrel is estimated at 30,500-38,000 pairs, which equates to 61,000-76,100 mature individuals (BirdLife International, 2015). Several thousand pairs breed outside this range, principally in central Asia (BirdLife International, 2016) which is considered likely to be the source population of the individuals passing through the development site. The population status of lesser kestrel is stable (BirdLife International, 2016).	Site
Lesser-spotted eagle	Least Concern	Three lesser-spotted eagles were recorded within the development site during the autumn survey period.	The European population is estimated at 16,400-22,100 pairs, which equates to 32,800-44,200 mature individuals	Site

Ecological Feature	Conservation Status	Baseline	Evaluation	Importance
		Collison risk modelling predicted 0.06 collisions per year, which is the equivalent of a collision every 16.17 years.	(BirdLife International 2015). Europe forms approximately 73 % of the global range, so a very preliminary estimate of the global population size is 44,900-60,500 mature individuals (Birdlife International, 2016). The population status of lesser-spotted eagle is stable (BirdLife International, 2016).	
Levant sparrowhawk	Least Concern	A single Levant sparrowhawk was recorded within the development site in the autumn survey period. Collison risk modelling predicted collisions 0.02 per year, which is the equivalent of a collision every 100 years.	The European population is estimated at 3,500-6,900 pairs, which equates to 7,000-13,800 mature individuals (BirdLife International 2015). Europe forms approximately 75-94 % of the global range, so a very preliminary estimate of the global population size is 7,400-18,400 mature individuals. The population size of Levant sparrowhawk is stable (BirdLife International, 2016).	Site
Long-legged buzzard	Least Concern	Thirty-seven long-legged buzzards were recorded within the development site during the full survey period. Collison risk modelling predicted 0.53 collisions per year, which is the equivalent of a collision every 1.89 years.	The European population of long-legged buzzard is estimated at 11,800-19,200 pairs, which equates to 23,700-38,400 mature individuals (BirdLife International 2015). Europe forms approximately 17 % of the global range, so a very preliminary estimate of the global population size is 139,000-226,000 mature individuals (Birdlife International, 2017). The population size of long-legged buzzard is stable (BirdLife International, 2017).	Site
Marsh harrier	Least Concern	A total of 129 marsh harrier were recorded within the development site during the full survey period. Collison risk modelling predicted 0.95 collisions per year, which is the equivalent of a collision every 1.06 years.	In Europe, the breeding population of marsh harrier is estimated at 99,300-184,000 breeding females, which equates to 199,000-367,000 mature individuals (BirdLife International, 2015). Europe forms approximately 48 % of the global range, so a very preliminary estimate of the global population size is 415,000-765,000 mature individuals (BirdLife International, 2016). The population size of marsh harrier is increasing (BirdLife International, 2016).	Site
Montagu's harrier	Least Concern	A total of 52 Montagu's harrier were recorded within the development site across the full survey period. Collison risk modelling predicted 0.10 collisions per year, which is the equivalent of a collision every 10.53 years.	The European population of Montagu's harrier is estimated at 54,500-92,200 breeding females, which equates to 109,000-184,000 mature individuals (BirdLife International 2015). Europe forms approximately 41 % of the global range, so a very preliminary estimate of the global population size is 266,000-449,000 mature individuals (BirdLife International, 2016). The population	Site

Ecological Feature	Conservation Status	Baseline	Evaluation	Importance
			size of Montagu's harrier is decreasing (BirdLife International, 2016).	
Osprey	Least Concern	A single adult osprey was recorded over the development site during the autumn survey period. Collison risk modelling predicted 0.02 collisions per year, which is the equivalent of a collision every 50 years.	The European population of osprey is estimated at 8,400-12,300 pairs, which equates to 16,700-24,600 mature individuals (BirdLife International 2015). Europe forms approximately 14 % of the global range, so a very preliminary estimate of the global population size is 119,000-176,000 mature individuals (BirdLife International, 2016). The population size of osprey is increasing (BirdLife International, 2016).	Site
Pallid harrier	Near Threatened	A total of 125 pallid harrier were recorded within the development site across the full survey period. Collison risk modelling predicted 0.15 collisions per year, which is the equivalent of a collision every 6.67 years.	The European population of pallid harrier is estimated at 300-1,100 breeding females, which equates to 600-2,300 mature individuals (BirdLife International 2015). The global population is estimated at 9,000-15,000 pairs. The population size of pallid harrier is decreasing (BirdLife International, 2016). The sub-population of pallid harrier migrating through the development site is considered likely to originate in the central Asian population strongholds of Kazakhstan and Russia (Terraube *et al.*, 2012). As a significant number of pallid harrier, a near threatened species, have been recorded within the development site a Regional level of importance is attributed.	Regional
Peregrine falcon	Least Concern	A single peregrine was recorded within the development site during the spring survey period. As the bird was observed flying below collision risk height there are no collisions predicted.	The European population is estimated at 14,900-28,800 pairs, which equates to 29,700-57,600 mature individuals (BirdLife International 2015). Europe forms approximately 13 % of the global range, so a very preliminary estimate of the global population size is 228,000-443,000 mature individuals (Birdlife International, 2016). The population size of peregrine falcon is stable (BirdLife, 2015).	Site
Purple heron	Least Concern	Nineteen purple herons were recorded within the development site in a single flock during the autumn migration period. Collison risk modelling predicted 0.58 collisions per year, which is the equivalent of a collision every 1.72 years.	The global population of purple heron is estimated at 270,000-570,000 individuals (Wetlands International 2015). The European population is estimated at 31,600-46,000 pairs, which equates to 63,100-92,100 mature individuals (BirdLife International, 2015). The population size of purple	Site

Ecological Feature	Conservation Status	Baseline	Evaluation	Importance
			heron is decreasing (BirdLife International, 2017).	
Saker falcon	Endangered	A single saker falcon was recorded within the development site during the autumn survey period. Collison risk modelling predicted 0.01 collisions per year, which is the equivalent of a collision every 100 years.	The global population of saker falcon is estimated at 12,200-29,800 mature individuals, based on national population estimates of breeding pairs that total c.6,100-14,900 breeding pairs (BirdLife International, 2015). The population size of saker falcon is decreasing (Birdlife International, 2016).	Local
Short-toed snake eagle	Least Concern	Six short-toed snake eagle were recorded within the development site across the full survey period. Collison risk modelling predicted 0.14 collisions per year, which is the equivalent of a collision every 7.41 years.	In Europe, the breeding population of short-toed snake eagle is estimated to number 17,600-20,900 breeding pairs, equating to 35,100-41,800 mature individuals (BirdLife International 2015). Europe forms approximately 34 % of the global range, so a very preliminary estimate of the global population size is 103,000-123,000 mature individuals (BirdLife International, 2016). The population size of short-toed snake eagle is stable (BirdLife International, 2015).	Site
Steppe buzzard	Least Concern	Records of over 7000 steppe buzzards within the development site were noted across the full survey period, primarily within the autumn survey period. A total of 5271 steppe buzzards were recorded during VP surveys. Collison risk modelling predicted 63.08 collisions per year, which is the equivalent of a collision every 0.02 years. Refined collision risk modelling for steppe buzzard predicted 38.88 collisions per year, which is the equivalent of a collision every 0.03 years.	BirdLife International and IUCN regard steppe buzzard as a sub-species of common buzzard. The European population of which is estimated at 814,000-1,390,000 pairs, which equates to 1,630,000-2,770,000 mature individuals (BirdLife International 2015). Europe forms approximately 75 % of the global range, so a very preliminary estimate of the global population size is 2,170,000-3,690,000 mature individuals. The population size for common buzzard is stable (BirdLife International, 2016). BirdLife International guidance for Important Bird and Biodiversity Areas (IBAs) states under Middle East criteria (B1 iv.) as a site where over 3,000 raptors regularly pass on spring or autumn migration is of high enough significance for a site to be recognised as of IBA importance (BirdLife International, 2017). The autumn migration of steppe buzzard recorded at the development site fulfils this criterion independent of all other species recorded.	Regional

Ecological Feature	Conservation Status	Baseline	Evaluation	Importance
Steppe eagle	Endangered	A total of 75 steppe eagle were recorded within the development site across the full survey period. Collison risk modelling predicted 1.06 collisions per year, which is the equivalent of a collision every 0.94 years. Refined collision risk modelling for steppe eagle predicted 0.77 collisions per year, which is the equivalent of a collision every 1.3 years.	Combined population totals from across the whole range estimate the number of pairs at 31,372 (26,014-36,731) which equates to 62,744 (52,028-73,462) mature individuals (BirdLife International, 2016). The conservation status of steppe eagle was changed from 'Least Concern' to 'Endangered' in 2015 owing to extremely rapid population declines. The global population continues to decline (BirdLife International, 2016). The population size of the sub-population of steppe eagle migrating through the Arabian Peninsula is unknown although there is evidence to suggest birds originating in Russia utilise the East Asian/East Africa Flyway in proximity to the development site (Satellite Tracking EU, 2017). As a significant number of steppe eagle, an 'Endangered' species, have been recorded within the development site a Provincial level of importance is attributed.	Regional I
Migratory raptor assemblage	Endangered (three species) Near Threatened (one species) Least Concern (20 species)	Over 8000 records of a total of 24 raptor species, discussed individually above, were recorded within the development site across the full survey period. A total of 247 records of 16 raptor species were logged in the spring survey period (March to May (inclusive)). The remaining 7792 records of 22 raptor species were in the autumn survey period (September and October). Excluding steppe buzzard, there were 748 records of a 21 raptor species assemblage recorded during the autumn migration period.	Twenty-four migrant raptor species of 'Endangered', 'Near Threatened' and 'Least Concern' conservation status (IUCN, 2017) have been recorded within the development site. The raptor migration observed within the development site during the autumn migration period meets BirdLife International guidance for the designation of IBAs under Middle East criteria (B1 iv.) as a site where over 3,000 raptors regularly pass on spring or autumn migration (BirdLife International, 2017).	Regional
Migratory bird assemblage (secondary species only)	Near Threatened (one species) Least Concern (38 species)	A total of 65 migrant species were recorded within the development site. Excluding the 26 target species discussed individually above a migrant assemblage of 39 species was recorded.	A minimum of 39 migrant secondary species have been recorded within the development site. All of these species are of 'Least Concern' conservation status with the exception of a vagrant little bustard, which is a first record for KSA, observed during the autumn survey period listed as 'Near Threatened' (IUCN, 2017).	Site
Resident bird assemblage	Least Concern (19 species)	A total of 84 bird species were recorded within the development site during the full survey period. Nineteen species are	A small number of the species recorded during baseline surveys breed in low densities within the development site. A	Site

Ecological Feature	Conservation Status	Baseline	Evaluation	Importance
(including breeding and wintering birds)		considered to be resident or semi-resident	minimum of 19 species are considered to be at least semi-resident within the development site, including wintering birds. Breeding may occur at any time of year although it is generally associated with periods following seasonal rainfall events in the winter and spring seasons. Suspected breeding birds include, but are not likely to be limited to, bar-tailed lark, brown-necked raven, cream-coloured courser, crested lark, desert lark, greater hoopoe-lark, pale crag martin, pharaoh eagle-owl, see-see partridge, Temminck's lark, trumpeter finch and white-crowned wheatear. All of these species are of 'Least Concern' conservation status (IUCN, 2017).	

11.7.3 Construction Phase Impacts

Impacts expected to be experienced during the construction phase of the Park relate to habitat loss and degradation, impacts of disturbance and increased risk of direct mortality / injury associated with the movement of construction plant and equipment. There are no predicted impacts on protected areas based on the Construction phase impacts are presented in Table 11-21.

Table 11-21: Potential Construction Impacts on Ecological Receptors

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB01	Protected Areas	National	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury Disturbance	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Indirect Unlikely Rare Short National Reversible	Negligible	Negligible
TB02	Migratory birds (incl. all target species)	Regional / Provincial / Local / Site	Habitat severance and disturbance leading to displacement.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Frequent Short Local Reversible	Low	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB03	Migratory birds (incl. all target species)	Regional / Provincial / Local / Site	Human presence leading to increased levels of hunting.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Indirect Likely Infrequent Short Local Reversible	Low	Low
TB04	Resident birds (incl. breeding and wintering birds)	Site	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury due to construction vehicles. Disturbance	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Local Reversible	Low	Low
TB05	Habitats	Site	Habitat loss Habitat degradation Habitat fragmentation	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Continuous Short Site Reversible	Low	Negligible
TB06	Floral Communities	Site	Habitat loss Habitat degradation	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Continuous Short Site Reversible	Low	Negligible
TB07	Mammal species	Site	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury Disturbance Pollution	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Site Reversible	Low	Negligible

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB08	Reptile species	Regional	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury Disturbance Pollution	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Site Reversible	Low	Low
TB09	Invertebrate species	Site	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Site Reversible	Low	Negligible
TB10	Bats	Site	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Site Reversible	Low	Negligible
TB11	Ecosystem Services - Regulating Services	Provincial	Impact on flood risk management	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Provincial Reversible	Low	Low
TB12	Ecosystem Services - Cultural Services	Regional	Loss of recreational amenity	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Frequent Short Regional Reversible	Moderate	Moderate
TB13	Ecosystem Services - Provisioning Services	Regional	Impact on grazing	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Provincial Reversible	Low	Low

11.7.3.1 Impact on protected areas

The Dawmat al Jandl IBA is located approximately 13km to the south of the Park and is comprised of an open, raised permanent reservoir basin with irrigation channels running to agricultural areas punctuated by very small, scattered remains of marshland. The development of the Park will not directly impact on the qualifying features of this proposed protected area, or impact on the integrity of communities within its boundary. Impact significance is assessed as negligible.

Impact TB01 – Negligible Significance

11.7.3.2 Impact on migratory birds (Habitat severance and disturbance)

There is potential for the disturbance of migratory bird species throughout, and adjacent to, the developable site due to construction activities. This may lead to displacement of passing migratory birds using the East Asian/East African migratory flyway.

Any effect would be short-term and negative pertaining only to migration periods and significant construction activities (e.g. turbine installation). The overall site is assessed to have low to moderate value for migratory bird species, although due to the short duration of the construction period this impact is of low significance.

Impact TB02 – Low Significance

11.7.3.3 Impact on migratory birds (Increased hunting pressure)

During the construction phase of the development, in-migration (i.e. workforce) is predicted. This would predominantly be associated with the establishment of an on-site construction workforce. A common pastime in KSA is hunting through trapping, falconry and shooting and increased human activity may lead to an increase in hunting.

Any effect would be short-term and negative and is likely to be ‘infrequent’, limited primarily to migration periods. The overall site is assessed to have low to moderate value for migratory bird species, although due to the ‘infrequency’ of impact and short duration of the construction period this impact is of low significance.

Impact TB03 – Low Significance

11.7.3.4 Impact on resident birds

There is potential for construction phase impacts on breeding birds, in particular during the site preparation activities (i.e. site grading and construction of roads). Impacts are predicted to include loss of breeding habitat (i.e. ground nesting sites), habitat degradation, habitat fragmentation, direct mortality and injury and disturbance. These impacts on breeding birds are assessed as short-term and negative due to the impact on breeding success.

Due to the low densities of breeding birds and the conservation status (Least Concern) of the species considered likely to breed within and adjacent to the developable area, impact significance is assessed as low.

Impact TB04 – Low Significance

11.7.3.5 Impact on habitats

There is no official system in the Kingdom of Saudi Arabia to designate or recognize the conservation value of habitats. Within the developable area of the Park, the habitats of greatest conservation value are associated with the minor wadi channels which drain the plateau and the edges of the plateau itself, characterized by steep cliffs and scree slopes.

The design of the Park has sought to avoid impacts on flow paths within the developable area of the Park and impacts of habitat loss and degradation are assessed as low significance. The wadi channels will also remain intact during the construction phase of the development and there are no impacts of habitat severance or fragmentation predicted.

Impact TB05 – Negligible Significance

11.7.3.6 Impact on floral communities

The floral communities within the developable area are mostly restricted to the wadi channels, and the design of the Park has sought to avoid impacts on these landscape features. The species recorded are ubiquitous within the Kingdom of Saudi Arabia and listed as Least Concern by the IUCN, and no endemic species have been recorded.

Impact significance on floral communities is assessed as low significance.

Impact TB06 – Negligible Significance

11.7.3.7 Impact on mammal species

Excluding bats, the conservation status of mammal species recorded during the baseline surveys is listed as Least Concern by the IUCN. Based on the design of the Park, significant impacts of habitat loss, degradation and fragmentation are not predicted. During the construction phase of the Park it will be possible for mammal species to migrate through the developable area using the existing wadi channels which will be retained.

Mammal species within the Kingdom of Saudi Arabia are mostly crepuscular and nocturnal. These periods of activity will naturally avoid construction activities which will be restricted to the working day. There are no planned night-works. Significant impacts of disturbance and direct mortality / injury on species of Least Concern are therefore assessed as unlikely.

Impact TB07 – Negligible Significance

11.7.3.8 Impact on reptile species

A total of seven reptile species were recorded within the project site. Only *Uromastyx aegyptia* is considered to be at risk during the construction phase of the Project. This species is listed as Vulnerable decreasing at both the regional and global level by the IUCN (Wilms *et al.*, 2012). It is also listed by the former National Commission for Wildlife Conservation & Development, now the Saudi Wildlife Authority, as a nationally threatened species and a species in which the conservation of populations within Saudi Arabia is essential to the conservation of the species globally.

It should be noted that at this stage of the assessment, only a single active burrow has been recorded within the developable area of the Park. Furthermore, pre-construction surveys for *Uromastyx aegyptia* will be undertaken, and if identified, a suitable experienced ecologist will develop and implement a translocation plan. This will involve the capture and release of *Uromastyx aegyptia* to suitably identified receptor habitat. Although not required by law, this is considered to be in the interests of animal welfare and the conservation status of *Uromastyx aegyptia* (i.e. vulnerable – decreasing). Impacts on *Uromastyx aegyptia* are therefore assessed as low significance.

Impact TB08 – Low Significance

11.7.3.9 Impact on invertebrate species

Faunal communities within the developable area of the Park are ubiquitous to the Kingdom of Saudi Arabia and are not yet classified by IUCN. Impact significance is assessed as negligible. Further surveys will be undertaken during autumn 2017 and the impact of construction activities re-evaluated.

Impact TB09 – Negligible Significance

11.7.3.10 Impact on bats

The conservation status of the bat species recorded during the baseline surveys is listed as Least Concern by the IUCN. Based on the design of the Park, set-back of the wind turbines from the edge of the plateau, significant impacts of habitat loss, degradation and fragmentation are not predicted during the construction phase. It has been assumed that construction activities will be restricted to normal working hours and will not require working at night. On this basis, impacts of disturbance and displacement are not predicted.

No bat roosts will be impacted during the construction phase of the development.

Impact TB10 – Negligible Significance

11.7.3.11 Ecosystem Services - Regulating Services

The preliminary design has accounted for the potential for impacts of flood risk and scour and erosion on the infrastructure of the Park and sought to avoid the risk through the placement of the wind turbines out of the minor wadi channels within the developable area of the Park. Construction activities will therefore avoid the wadi channels.

The hydrological function of the plateau area during periods of rainfall and pluvial run-off will remain unaffected by construction activities and the limited benefits that adjacent communities receive from the Regulating Services will remain unchanged.

Impact TB11 – Low Significance

11.7.3.12 Ecosystem Services – Cultural Services

During the construction phase of the Park, recreational activities that currently take place within the developable area of the Park will be interrupted, and there is likely to be a requirement to temporarily remove or relocate the informal gardens recorded within the developable area of the Park. Although the boundary of the Park will remain open and there will be no perimeter fencing, unauthorized access will be discouraged on the grounds of health and safety.

The temporary exclusion of people from the site, and direct impacts on the recreational enjoyment they derive from the site will impact on the Cultural Services that the developable area provides.

The effect would be short-term and negative, with respect to ecosystem services, and is assessed as moderate significance. The socio-economic aspects of construction phase impacts on the loss of recreational amenity are considered in Chapter 14 of the ESIA (i.e. Socio-economics).

Impact TB12 – Moderate Significance

11.7.3.13 Ecosystem Services - Provisioning Services

The developable area of the Park offers grazing for livestock, a Provisioning Service. During the construction phase of the Park, unauthorized access will be discouraged on the grounds of health and safety and accompanied grazing animals (i.e. in the presence of a herder) will be discouraged from entering the construction areas on the grounds of health and safety. This potentially has the impact of displacing grazing to adjoining areas, beyond the boundary of the Park, during the construction period.

The effect would be short-term and negative, and is assessed as low significance. The impact is low as opposed to moderate on the basis that only small numbers of grazing animals were recorded during the baseline surveys, and there is no indication to suggest that the developable area provides significant grazing. This impact is also further considered under the socio-economic impact assessment.

Impact TB13 – Low Significance

11.7.4 Operation Phase Impacts

The primary impact expected to be experienced during the operational phase of the Park is the risk of bird and bat collision with the new wind turbines, habitat fragmentation and the impact on ecosystem services. There are no predicted significant impacts on protected areas, habitats, floral, mammal, reptile or invertebrate communities during the operation of the Park. The operation phase impacts are presented in Table 11-22.

Table 11-22 : Potential Operational Phase Impacts on Ecological Receptors

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB14.a	Migratory birds: Steppe buzzard	Regional	Mortality due to collision with wind turbines.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Infrequent Short Local Reversible	Moderate	Moderate
TB14.b	Migratory birds: Black kite European honey buzzard Steppe eagle	Regional / Local	Mortality due to collision with wind turbines.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Local Reversible	Moderate	Low
TB14.c	Migratory birds: Marsh harrier Long-legged buzzard Purple heron	Site	Mortality due to collision with wind turbines.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Rare Short Local Reversible	Low	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB14.d	Migratory birds: Booted eagle Common crane Common kestrel Eastern Imperial eagle Egyptian vulture Eurasian hobby Eurasian sparrowhawk Golden eagle Griffon vulture Hen harrier Lesser kestrel Lesser-spotted eagle Levant sparrowhawk Montagu's harrier Osprey Pallid harrier Peregrine falcon Saker falcon Short-toed snake eagle All secondary species including migratory and resident bird assemblages	Regional / Local / Site	Mortality due to collision with wind turbines.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Rare Short Local Reversible	Low	Negligible
TB14.e	Migratory raptor assemblage	Regional	Mortality due to collision with wind turbines.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Infrequent Short Local Reversible	Moderate	Moderate
TB15	Migratory birds (incl. all target species.)	Local/Site	Disturbance leading to displacement. Habitat severance.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Frequent Short Local Reversible	Low	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB16	Bats	Site	Habitat degradation Direct mortality/injury Disturbance	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Provincial Reversible	Low	Low
TB17	Regulating Services	Provincial	Impact on flood risk management	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Provincial Reversible	Low	Negligible
TB18	Cultural Services	Regional	Loss of recreational amenity	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Frequent Short Regional Reversible	Low	Low
TB19	Provisioning Services	Regional	Impact on grazing	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Provincial Reversible	Low	Low

11.7.4.1 Impact on migratory birds (Collision risk)

The primary impact during the operational phase of the project is the risk of death or injury to birds colliding with the wind turbine infrastructure, particularly the rotor blades. Species have been separated by their susceptibility to collide with turbines based upon collision risk modelling analysis. The likelihood of occurrence for each species is based upon the *estimated* likelihood of a collision *each year* the development is in operation; certain (100 %), likely (> 50-99 %), unlikely (<50 %) and no impact (0 %). The frequency of occurrence for each species is based upon the *estimated* frequency of collision when the development is in operation; continuous (uninterrupted or on a daily basis), frequent (once or more per day), infrequent (less than once per day) and rare (single event/less than once a year).

The ornithological baseline study indicates steppe buzzard as the species most likely to collide with wind turbines at the development site. This species is predicted to have 63.08 collisions per year utilizing a precautionary model. A more refined collision risk model predicts 38.88 steppe buzzard collisions per year. These collision risk modelling results warrant a 'certain' likelihood of collisions occurring although frequency remains 'infrequent' as collision events are not estimated to occur on a daily basis.

As a number of collisions are predicted on an annual basis for steppe buzzard the magnitude of the impact has been assessed as moderate. The population of the nominate species, common buzzard, is of Least Concern conservation status and the population is currently stable (Birdlife International, 2016). The global population is very large, greater than two million individuals, and much greater than the number of birds predicted to collide during the full lifetime of the development over 25 years (Energy Yield Assessment, DNV GL, 2016). Nonetheless, as the sub-population of steppe buzzard passing through the region is under-studied and a significant number of records, over 7000 individuals, have resulted in collision risk estimates indicating regular mortality of birds a moderate overall significance has been attributed for steppe buzzard.

Impact TB14.a – Moderate Significance

The ornithological baseline study indicates black kite, European honey buzzard and steppe eagle, when combined with steppe buzzard, make up the four species likely to collide annually with wind turbines at the development site. A precautionary model predicted 1.48 collisions per year for black kite, 3.67 for European honey buzzard and 1.06 for steppe eagle. These collision risk modelling results warrant an 'infrequent' although 'likely' risk of collisions occurring at the development site on an annual basis.

As worst-case scenario collisions are predicted on an annual basis for these species a moderate magnitude has been attributed. Steppe eagle is listed as 'Endangered', although the number of birds observed at the development site and the subsequent number of predicted collisions with wind turbines is relatively low. As such the impact to these species is of low significance overall.

A refined collision risk model predicted lower collision risks for the three species and only European honey buzzard maintained an estimated risk of collision on an annual basis (2.04 collisions per year). The refined model predicted black kite (0.85 collisions per year) and steppe eagle (0.77 collisions per year) collisions would be fewer than one each year which indicates these two species could be reassigned to Impact TB14.c as, per the refined model, a single collision would be a 'rare' occurrence on an annual basis. The overall significance of the impact upon these species would remain as low in either category.

Impact TB14.b – Low Significance

There is greater than 50 % chance of a single collision each year (> 0.5 collisions per year) for a further three species; long-legged buzzard, marsh harrier and purple heron. These species are 'likely' to collide with wind turbines during the full lifetime of the development although on a 'rare' basis only. All of these species have very large global populations and are listed as Least Concern conservation status, therefore a 'low' magnitude and significance of impact has been attributed overall.

Impact TB14.c – Low Significance

The remaining 18 target species, and all secondary species recorded on-site, are 'unlikely' to collide with wind turbines due to their flight behaviors or low levels of presence within the development site. A low magnitude of significance is maintained although the overall significance of the operational impacts upon these species is negligible.

Impact TB14.d – Negligible Significance

The ornithological baseline study indicates regionally significant raptor migration through the development site, particularly during the peak autumn migration period (September and October). The cumulative impact of collisions leading to injury and death on an annual basis for four of the 24 species recorded is of moderate magnitude.

Due to worst-case scenario collision risk modelling estimates indicating the 'certain' likelihood of 'infrequent', collisions leading to mortality of multiple species the overall significance of this impact has been assessed as moderate.

Impact TB14.e – Moderate Significance

11.7.4.2 Impact on migratory birds (Disturbance)

As discussed for Impact TB02 there is potential for the disturbance of migratory bird species throughout, and adjacent to, the developable site, due to the presence of wind turbines. This may lead to displacement of passing migratory birds utilizing the broad-fronted East Asian/East African migratory flyway.

Any effect would be short-term and negative pertaining to migration periods throughout the lifetime of the development. The overall site is assessed to have low to moderate value for migratory bird species and due to the infrequency of impact, and lack of direct impact (i.e. mortality); a low significance has been attributed.

Impact TB15 – Low Significance

11.7.4.3 Impact on bat species

Arnett (2005) investigated the relationship between bats and wind turbines at wind energy power plants in the United States of America using thermal imaging technology. The research has shown that some bats forage around and within the rotor-sweep zone of the turbine blades, and thermal images of bats attempting to land or actually landing on stationary blades and the turbine mast generally support the roost attraction hypothesis. Although further research is required, this preliminary evidence suggests that displacement by turbines may not be significant for certain species (Arnett, 2005).

Studies which have investigated the risk of collision have generated highly variable mortality data, but the risk of mortality does appear to be higher in proximity to well vegetated habitats and where wind energy power plants are positioned along the paths of long-distant migratory bat species (Arnett, 2005).

Kuhl's pipistrelle is known to be widespread and relatively abundant in the Middle East, and is classified as being of 'Least Concern' from a conservation perspective for these reasons. It is known to inhabit a variety of habitats, including desert, but most favours urban habitats and areas with settlements nearby (presumably for roosting). Research has identified that in general, bats within the *Pipistrellus* genera are of high or medium risk of fatality through direct collision / barotrauma from wind turbine blades (Natural England, 2012; Sowler and Soffberg, 2014; Rydell *et al,* 2010). Fatality figures from the Brandenburg Institute in Germany (Data from the central register of the State Fund Ornithological Station in State Office for Environment, Health and Consumer Protection of Brandenburg, 2012) have reported a total of 151 Kuhl's pipistrelle fatalities across Europe (most from the Mediterranean area) and collision impacts should be considered likely for this species.

The Sind bat is known to inhabit semi-desert terrain and sand dunes next to the sea (Harrison and Bates, 1991). It is listed as being of 'Least Concern' from a conservation perspective due to its relatively wide distribution, tolerance of habitat modification, and "because it is unlikely to be declining fast enough to qualify for listing in a more threatened category" (http://www.iucnredlist.org/details/7935/0, accessed 30.11.2017).

Botta's serotine is described by the IUCN as follows: "*has a relatively wide range. Although generally considered uncommon it is described as locally common in at least part of the range (Egypt). No major threats are known. Hence it is listed as Least Concern. Found in a wide range of semi-arid habitats including Mediterranean vegetation, lowland farmland and rocky mountains. A crevice dwelling species, inhabiting buildings, ruins (including tombs), and natural rock crevices throughout the year*" (http://www.iucnredlist.org/details/7915/0, accessed 30.11.2017).

Research has identified that in general, bats within the *Eptesicus* genera are of medium risk of fatality through direct collision / barotrauma from wind turbine blades. Fatality figures from the Brandenburg Institute in Germany have reported a total of 311 *Eptesicus* fatalities (involving serotine *Eptesicus serotinus*, Isabelline serotine *Eptesicus isabellinus*, and northern bat *Eptesicus nilssonii*) across Europe and collision impacts should be considered likely for this species. Research in Europe has also shown that serotines avoid areas where wind farms have been installed (Bach and Rahmel, 2004). Therefore, displacement impacts also need to be considered for this species.

The Egyptian free-tailed bat is found in a wide range of habitats, including desert regions (Dietz and Kiefer, 2016). It identified by the IUCN as being "broadly distributed and locally common" and is therefore identified as being of 'Least Concern' from a conservation perspective (http://www.iucnredlist.org/details/21312/0, accessed

30.11.2017). Bats within the *Tadarida* genus are fast flyers, generally hunting relatively high above the ground (10 m+). Egyptian free-tailed bats have been identified as making up a substantial proportion (44 %) of the bat casualties identified at an operational South African wind farm (Doty & Martin, 2013). It has also been identified that seasonality appeared to play a part, with most casualties identified during the autumn. In addition, Fatality figures from the Brandenburg Institute in Germany have reported a total of 35 fatalities for European free-tailed bat *Tadarida teniotis* and collision impacts should be considered likely for this species.

The desert long-eared bat is found in extremely barren and arid regions (http://eol.org/pages/981691/details). It is identified by the IUCN as being of least concern as although the current population trend isn't known, it is relatively common in desert and sub-desert habitats in the south west Palaearctic region. The desert long-eared bat species which forages using aerial hawking and passive listening / gleaning methods. When gleaning this bat flies close to the ground (40–100 cm), landing to catch prey, which are then consumed while the bat adopts a slow, gliding and widely circling flight 3–7 m above the ground, when aerial hawking the bat can fly at heights of up to approximately 10 m. In general, long-eared bats are considered to be at low risk of direct collision / barotrauma from wind turbine blades, with just 12 fatalities of *Plecotus* species (grey long-eared bat *Plecotus austriacus* and brown long-eared bat *Plecotus auritus*) recorded across Europe by 2012.

When considering the impact of the proposed windfarm, the low level of activity recorded should be acknowledged, however a precautionary approach should be taken based on the limited sampling completed and taking into account the localized high level of activity recorded at Autumn 2. It is possible that bat activity is sporadically high and/or localized across the site. For example, it is known that the lesser mouse-tailed bat *Rhinopoma hardwickii* migrates with brief occurrences of large to very large colonies in areas which the species is not found at other times of year.

Consideration should be given to the completion of post construction monitoring using static detectors, periodical carcass searches and associated analysis of data to provide an estimate of mortality due to collision in a given period. This should include (as for birds) scavenger removal rate trials (outside of the development site); and searcher efficiency trials. This could be important as research in Europe has shown that the level of pre-construction activity recorded does not necessarily equate to the level of mortality observed (Matthews *et al*, 2016).

Research in the UK has shown that the level of bat activity decreases in low temperatures and high wind speeds (Slack & Tinsley, 2015). If the level of mortality is identified as being too great, work should be completed to identify in which conditions, and times of night, bats are active within each area, with consideration given to curtailing the operation of problem turbines during specific conditions, as certain times of the night / year. This has proven to be effective at other wind farm sites (Baerwold *et al,* 2009).

Although there is a risk that the bat species recorded within the developable area may be at risk of displacement and collision with the wind turbines, the bat activity across the developable area is generally assessed to be low and the species recorded are listed as Least Concern by the IUCN. The turbines will also be set back from the perimeter of the plateau and this major feature of the landscape which has the potential to be used for commuting. The impact of the Park on bats is therefore assessed as being of low significance.

Impact TB16 – Low Significance

11.7.4.4 Ecosystem Services - Regulating Services

The Regulating Services that the minor wadi channels within the developable area of the Park provide will remain uninterrupted during the operation of the Park, and there will be no change to the flow routes or risk of flooding, either within the developable area of the Park or beyond the boundary of the Park. The hydrological performance of existing Regulating Services and the limited benefits that local communities derive from them will remain unchanged.

Impact TB17 – Negligible Significance

11.7.4.5 Ecosystem Services – Cultural Services

The boundary of the Park will not be fenced and during its operation, it will be possible for local communities to derive recreational amenity value from the project site, similar to that derived prior to development. There are no significant impacts predicted on Cultural Services currently provided by the developable area of the Park.

Impact TB18 – Low Significance

11.7.4.6 Ecosystem Services - Provisioning Services

The boundary of the Park will not be fenced and during its operation, grazing animals will be able to move freely through the development. The Provisioning Service that the developable area offered prior to development will continue during the operation of the Park as the grazing habitat (i.e. the wadi channels) will remain intact.

Impact TB19 – Low Significance

11.7.5 Decommissioning Phase Impacts

Impacts expected to be experienced during the decommissioning phase are broadly similar to those predicted during the construction phase of the Park, although the effect will be positive. Construction and operation phase impacts of negligible significance have not been considered further.

However the removal of the wind turbines has the potential to restore the site to its pre-development condition and remove the infrastructure which poses a collision risk to both birds and bats. Decommissioning impacts are presented in Table 11-23.

Table 11-23: Potential Decommissioning Phase Impacts on Ecological Receptors

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB20.a	Migratory birds (incl. all target and secondary assemblages)	Regional / Provincial / Local / Site	Habitat severance and disturbance leading to displacement	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Frequent Short Local Reversible	Low	Low
TB20.b	Migratory birds (incl. all target and secondary assemblages)	Regional / Provincial / Local / Site	Human presence leading to increased levels of hunting	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Indirect Likely Infrequent Short Local Reversible	Low	Low
TB20.c	Migratory birds (incl. all target and secondary assemblages)	Regional / Provincial / Local / Site	Upon completion of the decommissioning phase the collision risk posed by wind turbines will be removed.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Positive Direct Likely Continuous Long Local Reversible	Low	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB20.d	Resident bird assemblage (incl. breeding and wintering birds)	Site	Direct mortality / injury due to decommissioning activities. Disturbance.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Frequent Short Local Reversible	Low	Low
TB21	Bats	Site	Upon completion of the decommissioning phase the collision risk posed by wind turbines will be removed.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Positive Direct Likely Continuous Long Local Reversible	Low	Negligible
TB22	Cultural Services	Regional	Loss of recreational amenity	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Positive Direct Likely Infrequent Short Regional Reversible	Moderate	Moderate

11.7.5.1 Impact on migratory birds

There is potential for the disturbance of migratory bird species throughout, and adjacent to, the development site due to decommissioning activities. This may lead to displacement of passing migratory birds using the East Asian/East African migratory flyway.

Any effect would be short-term and negative pertaining only to migration periods and significant decommissioning activities (e.g. turbine removal). The overall site is assessed to have low to moderate value for migratory bird species although due to the infrequency of impact and short duration of the decommissioning period this impact is of low significance.

Impact TB20.a – Low Significance

During the decommissioning phase of the development, in-migration (i.e. workforce) is predicted. This would predominantly be associated with the establishment of an on-site construction workforce. A common pastime in the Kingdom is hunting through trapping, falconry and shooting and increased human activity may lead to an increase in hunting.

Any effect would be short-term and negative and is likely to be infrequent, limited primarily to migration periods. The overall site is assessed to have low to moderate value for migratory bird species although due to the infrequency of impact and short duration of the decommissioning period this impact is of low significance.

Impact TB20.b – Low Significance

The decommissioning phase at the development site is likely to have a positive effect on migratory birds as the risks and impacts present during the operation of the scheme are removed, particularly the risk of collision with wind turbines.

Impact TB20.3 – Low Significance

11.7.5.2 Impact on resident birds

There is potential for decommissioning phase works to impact upon breeding birds through direct mortality, injury and disturbance associated with decommissioning machinery. These impacts on breeding birds are assessed as short-term and negative due to the impact on breeding success.

Due to the low densities of the breeding birds, the conservation status (Least Concern) of the breeding species present, combined with decommissioning activities limited to areas of existing disturbance, such as turbine locations and access roads, the impact significance is assessed as low.

Impact TB20.d – Low Significance

11.7.5.3 Impact on bats

The decommissioning phase at the development site is likely to have a positive effect on bats as the risks and impacts present during the operation of the scheme are removed.

Impact TB21 – Negligible Significance

11.7.5.4 Ecosystem Services – Cultural Services

The decommissioning phase at the development site and the removal of the wind turbines will enable the restoration of pre-development land-uses, and the cultural services from which local communities derive benefit will be fully restored. The socio-economic aspects of decommissioning phase impacts on the benefit to recreational amenity are considered in Chapter 14 of the ESIA (i.e. Socio-economics).

Impact TB22 – Moderate Significance

11.8 Mitigation and Recommendations

The assessment of impact demonstrates that the likelihood of significant adverse effects during construction, operation and decommissioning is mostly low to negligible, predominantly at the site level only. There are however moderate impacts predicted on ecosystem services during both the construction and operation phases of the Park.

11.8.1 Construction Phase

Mitigation measures required during the construction phase of the Park are listed in Table 11-24.

Table 11-24 : Construction Phase Mitigation Measures

ID	Potential Significance	Mitigation Measures	Residual Significance
TB12	Moderate	During the construction phase of the development it is recommended that engagement with local communities is undertaken to local communities understand the phasing of the development and impact on informal gardens within the boundary of the Park. Working in partnership, the IPP and hunters should identify safe corridors and zones for access based on the phasing of construction, and develop plans to mitigate and compensate for the loss of informal gardens. These actions will minimize the impact of displacing local communities who access the site to adjoining areas, beyond the boundary of the Park, during the construction period.	Low

In addition to the specific mitigation measures recommended in Table 11-24, the following good practice recommendation should be implemented during construction.

- Prior to site clearance works, it is recommended that a competent terrestrial ecologist completes a walk-over survey. The objective of the survey is to ensure that the baseline conditions of the site remain the same and have not changed. If active large mammal burrows (i.e. red fox) are recorded, it is recommended that a competent ecologist oversees the exclusion and possible translocation of these species. Although not required by law, this is considered to be in the interests of animal welfare.

- The pre-construction walk-over survey should include completing a survey for ground-nesting bird species. If nesting birds are recorded, active nests should be identified wherever practicable and an exclusion zone established until the nest is no longer active.

- Construction site rules should prohibit any hunting activity as a direct result of the establishment of an on-site construction workforce throughout the construction phase

11.8.2 Operation Phase

Mitigation measures required during the operation phase of the Park are listed in Table 11-24.

Table 11-25 : Operation Phase Mitigation Measures

ID	Potential Significance	Mitigation Measures	Residual Significance
TB14.a	Moderate	On the basis of the information gathered at the development site to date there is potential for moderate impacts to migratory species, particularly the most abundant target species, steppe buzzard. Although the estimated collisions are low compared to the numbers of birds recorded at the development site it remains of significance that regular mortality is predicted for the lifetime of the development, not including other migrant species in smaller number (**Impacts TB14.b, TB14.c, TB14.e)**. Post-construction monitoring is recommended to provide additional information on how the bird species present will respond to the development of the Park. Post-construction monitoring should include, although not be limited to, the following: • a minimum of three years' post-construction monitoring; • undertaken by minimum of two suitably experienced ornithologists at all times whilst on-site; • focus on peak autumn migration period (September and October); • migratory bird surveys focused on assessing the behavior of target species passing through the development site; and • periodical carcass searches and associated analysis of data to provide an estimate of mortality due to collision in any given migration period, including; o scavenger removal rate trials (outside of the development site); and o searcher efficiency trials. The results of post-construction monitoring should be reported on an annual basis. If impacts are found to be greater than those predicted within the baseline ornithological report, and those discussed within the ESIA, further considerations of site-specific mitigation measures will be made. These mitigation measures may include, although not be limited to, the following: • appointing suitably experienced ornithologists on-site to request temporary shutdown individual turbines, during the peak autumn migration period, if large numbers of migrating birds are observed on course for the turbine area at collision risk height; • consideration of automated technologies which can detect, and provide direct acoustical warning to, birds approaching turbines or those detected within the turbine area; and • consideration of automated technologies which can detect, and shutdown individual turbines, when birds are in proximity to operational turbines.	Low
TB14.e	Moderate	As discussed above for Impact TB14.a.	Low

In addition to the specific mitigation measures recommended in Table 11-25, to monitor the potential long term impacts of the Dumat al Jandal Wind Energy Park on migratory and resident breeding bird species, it is recommended that any bird carcasses discovered during routine and scheduled maintenance are recorded (i.e. photo, species and suspected cause of death) throughout the lifetime of the Park. This information will contribute towards a better understanding of the potential impact of the Park and permit the implementation of further control measures if necessary.

Consideration should also be given to the completion of post construction monitoring for bats using static detectors, periodical carcass searches and associated analysis of data to provide an estimate of mortality due to collision in a given period. This should include (as for birds) scavenger removal rate trials (outside of the development site); and searcher efficiency trials. This could be important as research in Europe has shown that the level of pre-construction activity recorded does not necessarily equate to the level of mortality observed (Matthews *et al,* 2016).

Research in the UK has shown that the level of bat activity decreases in low temperatures and high wind speeds (Slack and Tinsley, 2015). If the level of mortality is identified as being too great, work should be completed to identify in which conditions, and times of night, bats are active within each area, with consideration given to curtailing the operation of problem turbines during specific conditions, as certain times of the night / year. This has proven to be effective at other wind farm sites (Baerwald *et al,* 2009).

11.8.3 Decommissioning Phase

The decommissioning of the Park creates an opportunity to restore the site and land-uses prior to development. This is assessed as a moderate significance positive impact. Although this does not necessitate any mitigation, it is recommended that the IPP engages with the local community during this phase of the development.

Prior to decommissioning works, it is recommended that a competent terrestrial ecologist completes a walk-over survey. The objective of the survey is to define the baseline conditions prior to significant decommissioning activities. This includes completing a survey for ground-nesting bird species. If nesting birds are recorded, active nests should be identified wherever practicable and an exclusion zone established until the nest is no longer active. Decommissioning site rules should prohibit any hunting activity as a direct result of the establishment of an on-site workforce throughout the decommissioning phase.

Any repowering or redevelopment of the development site extending the lifetime of the project should reconsider ornithological impacts and it is recommended that baseline surveys and collision risk modelling is updated.

11.9 Conclusion

The developable area of the Dumat Al Jandal Wind Energy Park supports a range of ecological receptors, the conservation status of which is mostly sensitive at the site or local level only. The exceptions are the Duwmat al Jandl IBA which is valued at the National level, and the Egyptian spiny tailed lizard *Uromastyx aegyptia* which is valued at the Regional level.

The conservation status of the majority of ecological receptors is valued at site / local level only; although the migratory bird assemblage and Pallid Harrier, Steppe Eagle and Steppe Buzzard are valued as Regional conservation status.

The developable area of the Park currently provides regulating, cultural and provisioning services. The construction and operation of the Park are not predicted to significantly impact on the regulating or provisioning ecosystem services. Construction impacts of moderate significance are predicted on cultural services. With mitigation these can be reduced to low.

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12. Archaeology and Cultural Heritage

12.1 Introduction

This chapter provides an assessment of cultural heritage assets found within the development site and assesses the impact of the Dumat Al Jandal Wind Energy Park (the 'Park') upon them. Assessment of cultural heritage was undertaken based on guidance provided by *Performance Standard 7: Indigenous Peoples* and *Performance Standard 8: Cultural Heritage* (International Finance Corporation (IFC) 2012a, 2012b), and *Guidance on Heritage Impact Assessments for Cultural World Heritage Properties* (International Council on Monuments and Sites (UNESCO) 2011).

Based on guidance provided by ICOMOS (2011) and IFC (2012a, 2012b) cultural heritage was considered to comprise:

(i) '*tangible forms of cultural heritage'*; defined as moveable or immovable objects, property, sites, structures, or groups of structures, having archaeological (prehistoric), paleontological, historical, cultural, artistic, and religious values;

(ii) '*unique natural features or tangible objects*' embodying cultural values, such as sacred groves, rocks, lakes, and waterfalls; and,

(iii) certain instances of 'intangible forms of culture' that are proposed to be used for commercial purposes, such as cultural knowledge, innovations, and practices of communities embodying traditional lifestyles.

12.2 International and National Standards and Guidance

12.2.1 International Conventions

Treaties concluded or ratified by Saudi Arabia relating to cultural heritage and relevant to this assessment comprise:

- United Nations Educational, Scientific and Cultural Organization, 1972. *Convention Concerning the Protection of the World Cultural and Natural Heritage*. UNESCO; and,
- United Nations Educational, Scientific and Cultural Organization, 2003. *Convention for the Safeguarding of Intangible Cultural Heritage*. UNESCO (ratified 2008).

12.2.2 International Council on Monuments and Sites

The International Council on Monuments and Sites (ICOMOS) has produced Guidance on Heritage Impact Assessments for Cultural World Heritage Properties (ICOMOS 2011). The guidance is aimed at managers, developers, consultants and decision-makers, and offers guidance on the process of commissioning Heritage Impact Assessments (HIAs) for World Heritage (WH) properties, with the intention of evaluating effectively the impact of potential development on the Outstanding Universal Value (OUV) of properties. Properties of OUV are recognized as properties which deserve protection for future generations, as a result of their heritage value.

Where change may affect the OUV of a WH property, consideration of the cultural [and/or natural] heritage attributes should be central to planning any proposal and should be presented early on in any general assessment. Managers and decision makers should consider whether the heritage conservation needs should be given greater weight than competing uses and developments.

12.2.3 IFC Performance Standards

The IFC performance standards (as described in Chapter 2 Policy, legal and Administrative Framework) highlight the necessity to consider cultural heritage on major development projects. The following performance standards are of particular relevance to this chapter:

- IFC Performance Standard 7 (IFC 2012a) – Indigenous Peoples; and,

- IFC Performance Standard 8 (IFC 2012b) – Cultural Heritage.

12.2.3.1 IFC Performance Standard 7

Performance standard 7 identifies Indigenous Peoples as groups with identities that are distinct from mainstream groups in national societies. The performance standard recognizes that these groups are often amongst the most marginalized segments of a population. The guidance recommends that projects should ensure that the development process fosters full respect for the human rights and culture of Indigenous Peoples, avoiding where possible adverse impacts and promoting sustainable development in a culturally appropriate manner.

Development on land closely tied to Indigenous Peoples, as well as the relocation of Indigenous Peoples as a result of projects, are two key issues. The client should carefully consider whether the issues can be avoided at first, with carefully set out management plans in the performance standard implemented if avoidance cannot be achieved.

The key objectives of this Performance Standard are:

- To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples.
- To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts.
- To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner.
- To establish and maintain an ongoing relationship based on informed consultation and participation with the Indigenous Peoples affected by a project throughout the project's life-cycle.
- To ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present.
- To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.

12.2.3.2 IFC Performance Standard 8

Performance standard 8 recognizes the importance of cultural heritage for current and future generations. In doing so, the performance standard has objectives to protect cultural heritage from adverse project impacts, support preservation and promote the equitable sharing benefits from the use of cultural heritage.

The guidance states that a client should identify and protect cultural heritage by ensuring that internationally recognized practices for the protection, field-based study, and documentation of cultural heritage are implemented by competent professionals.

Chance finds can also be discovered on construction projects. Clients should develop provisions for managing chance finds through a chance find procedure, which sets out the actions to be taken if unknown cultural heritage features are encountered.

Of relevance to the Park, IFC Environmental, Health and Safety (EHS) Guidelines for Wind Energy (2015) must be adhered to. The location of a wind farm can have a visual impact on legally protected and international recognized cultural heritage features (sites with archaeological, paleontological, historical, cultural, artistic and religious values). Preparing zone of visual influence maps and preparing wire-frame images and photomontages from key viewpoints is recommended to inform both the assessment and the consultation processes. For a full assessment of the visual impacts of the Park, see chapter 10, *Landscape and Visual Impact.*

Key objectives of this performance standard are:

- To protect cultural heritage from the adverse impacts of project activities and support its preservation ; and,
- To promote the equitable sharing of benefits from the use of cultural heritage in business activities.

It is a requirement of Performance Standard 8 that consultation is carried out. Paragraph 6 states:

"Where a project may affect cultural heritage, the client will consult with affected communities within the host country who use, or have used within living memory, the cultural heritage for longstanding cultural purposes to identify cultural heritage of importance, and to incorporate into the client's decision-making process the views of the affected communities on such cultural heritage. Consultation will also involve the relevant national or local regulatory agencies that are entrusted with the protection of cultural heritage."

12.3 Baseline Environmental Conditions

12.3.1 Baseline Review

12.3.2 Objectives

The objectives of this screening study are to:

- characterize the historic environment within the Al Jouf province;
- characterize the historic environment within 25 km of the development site;
- identify heritage assets within the footprint of and within a 10 km Study Area around the development site; and,
- assess the potential for impact on cultural heritage as a result of the proposed scheme.

12.3.3 Study Area

Based on professional judgement and guidance provided by ICOMOS (2011) a Study Area for the development site has been defined as the footprint of the site and an area extending 10 km in all directions from it (Figure 12-1).

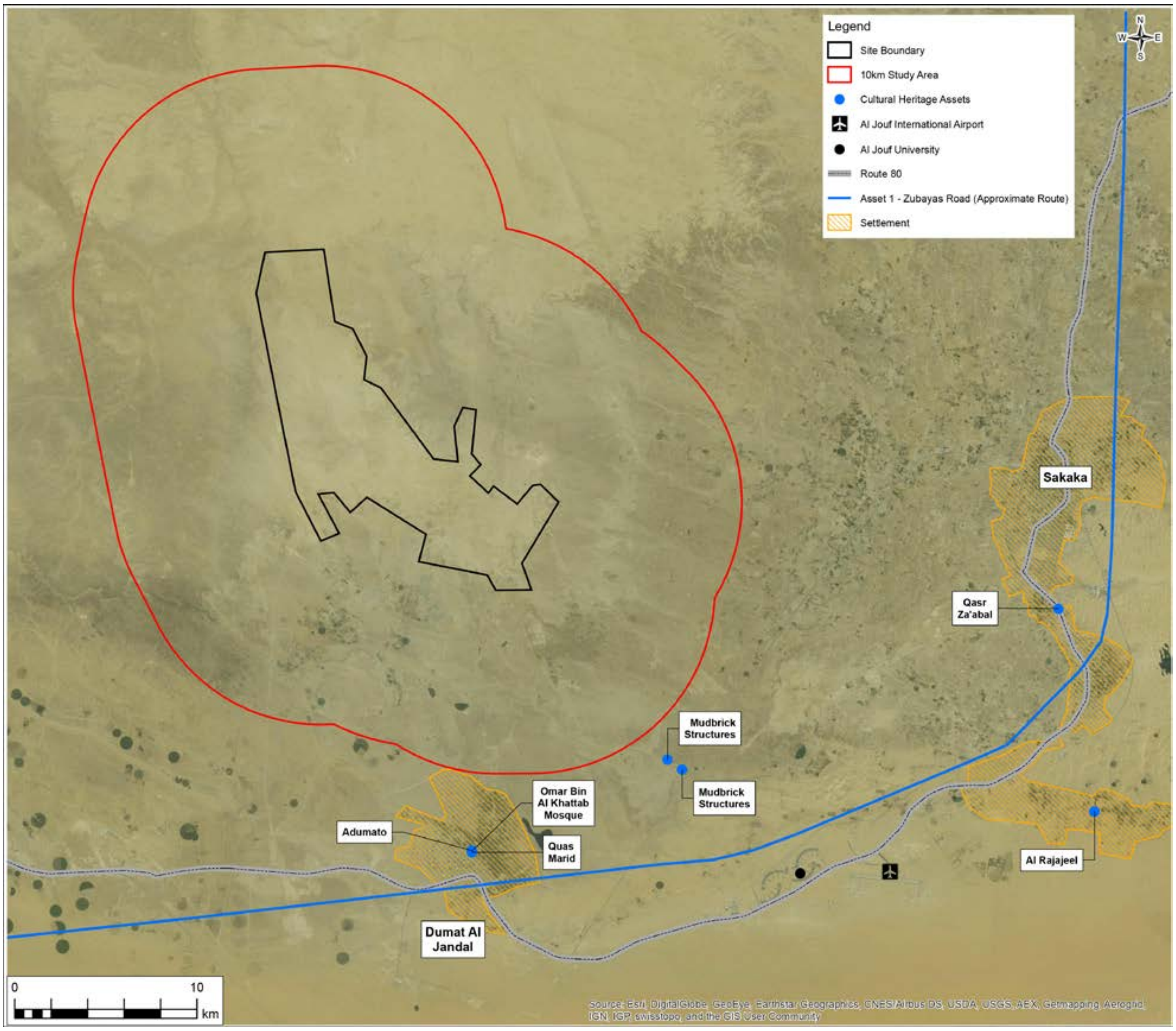

Figure 12-1: Study Area

12.3.4 Data gathering

The following sources of information were consulted:

- Google Earth for information on archaeological sites in Al Jouf Province;
- Saudi tourism website for information on cultural heritage in Al Jouf Province;
- Saudi Commission for Tourism and National Heritage for information on locally identified archaeological sites; and,
- UNESCO Intangible Cultural Heritage List for information on relevant intangible cultural heritage.

Furthermore, consultation with the Saudi Commission for Tourism and Antiquities (SCTA) was undertaken.

12.3.5 Archaeological and historical background

12.3.5.1 Summary

The earliest evidence for human habitation on the Arabian Peninsula, derived from archaeological work in Yemen, dates to approximately 53,000 BC (Delganes 2012). The Arabian Peninsula was home to some early settled peoples, including the Dilmun civilization, one of the oldest in the Middle East, dating to the 3rd millennium BC.

Mesopotamian records regard Dilmun as an important trading center, controlling the Persian Gulf trade routes. The Thamud, Kindah and Al-Magar civilizations flourished in the Arab peninsula from the 1st millennium BC to the time of Muhammad. Muhammad and his companions united the tribes of Arabia under Islam, creating a single Arab Muslim religious polity in the Arab Peninsula. The modern state of Saudi Arabia was formed in 1932 when the two kingdoms of the Hejaz and Najd kingdoms united.

12.3.5.2 The development site

The Dumat Al Jandal development site is located within the Al Jouf Province, approximately 15 km to the north of Dumat Al Jandal and 25 km to the west of Sakaka. The area of the development site includes parts of the An Nafud Desert, a 'dune sea'; a flat area of desert covered with windswept sand with little or no vegetative cover. These extreme conditions have made travel across the region difficult.

Before the Battle of Aqaba (during the Arab Revolt of 1916) forces led by Auda ibu Tayi attacked the Turkish-held coastal town of Aqaba on its poorly defended eastern flank, achieved by taking a long and wide desert route, passing close to the edge of Al Nafud.

A number of significant archaeological sites are present within 25 km of the Dumat site. The ancient settlement of Dumat Al Jandal is located 15 km to the south. The settlement includes the remains of Qasr Marid, the city of Adumato, an Akkadian settlement, and the Omar Bin Al Khattab mosque. The Dumat site is located approximately 20 km to the north of the modern road Route 80. This follows the Arabian route of the Hajj from Baghdad and Kufa to Mecca.

12.3.5.3 Tangible forms of cultural heritage

No tangible heritage assets have been identified within the footprint of the Dumat Al Jandal site or within the 10km study area from sources identified in section 12.3.4.

However, the SCTA has provided records of archaeological assets in close proximity to the southern boundary of the Park. There is a cluster of assets located approximately 8.5km to the south-west of the Park, and several assets located to the immediate south of the Park (Figure 12.2). These assets are comprised of a series of old stone circular structures 2.5 – 3m in diameter, and boundary walls constructed from local sandstone (Figure 12.3).

These assets are collectively called Murair 1 and Murair 2 and are believed to have a military function, dated to the 20th Century. Some of the boundary walls are observed to contain small openings which might have been used for defense (i.e. rifle placements).

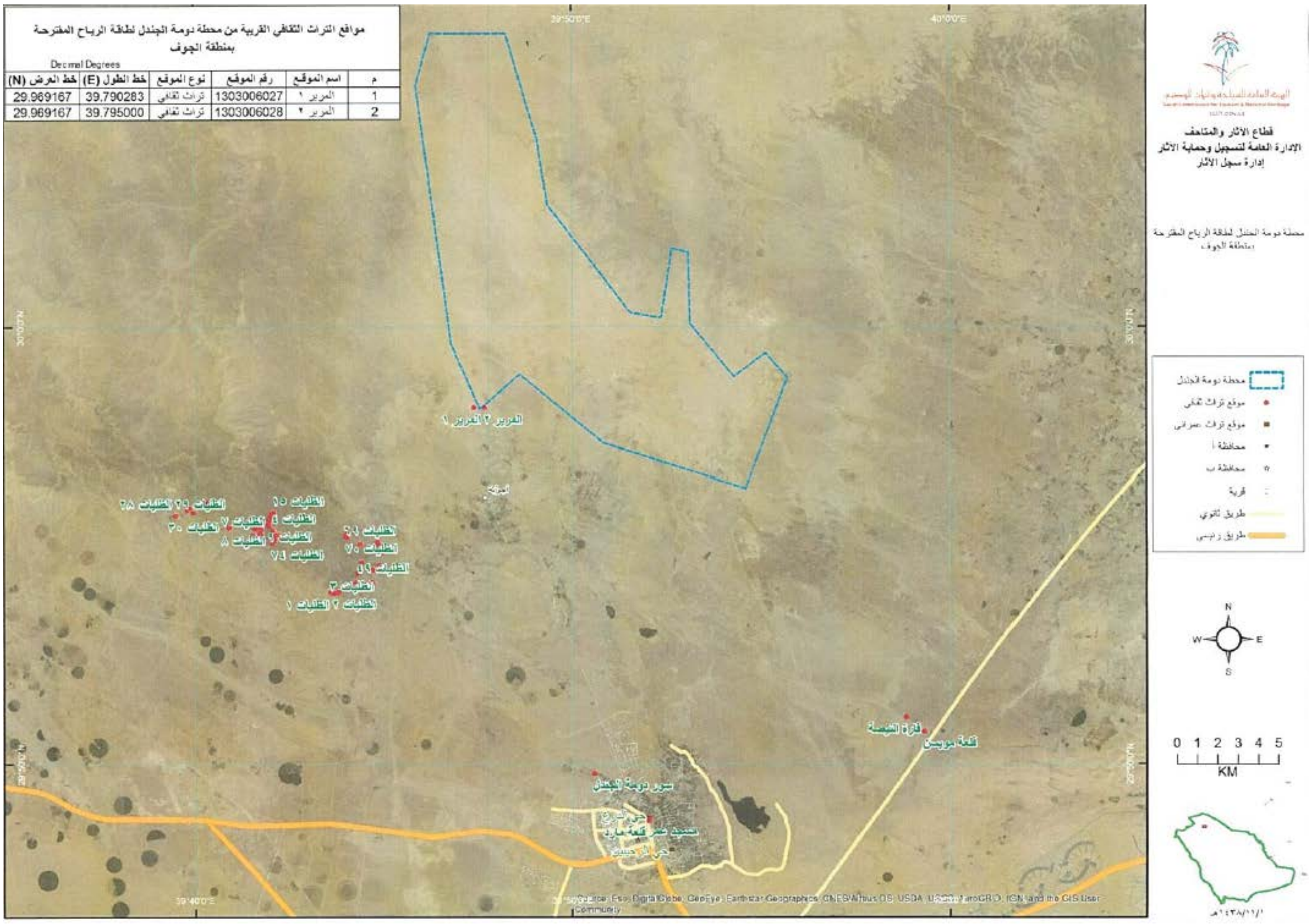

Figure 12.2 : Location of Cultural Heritage Assets Provided by Saudi Commission for Tourism and Antiquities

Figure 12.3 : Image of stone structure to the immediate south of Park (source: SCTA)

12.3.5.4 Unique natural features or tangible objects

No unique natural features or tangible objects have been identified within the footprint of the Dumat Al Jandal site or within the 10 km study area from sources identified in section 12.3.4.

12.3.5.5 Intangible forms of culture

12.3.5.5.1 Very high value

No intangible forms of culture have been identified within the footprint of the Dumat Al Jandal site or within the 10km study area from sources identified in section 12.3.3.

12.3.5.6 Potential for unknown archaeological remains

While the Dumat Al Jandal site is located to the north of Dumat Al Jandal (home to several significant archaeological sites) it is also partly located in the large desert area of ‘Al Nafud’. The Dumat Al Jandal site is also approximately 15 km to the north of Zubayda’s Road (Asset 1; very high value). Rock art sites are known to be found within the area. This evidence presents some potential for unknown archaeological sites and un-stratified finds. The potential for unknown archaeological remains has been assessed to be low.

12.3.6 Baseline Survey - Methodology

A baseline field walkover survey was carried out to confirm the findings of the desk based assessment.

12.3.7 Baseline Survey - Results

No additional cultural heritage features were found in the field, above those identified during the baseline survey.

12.4 Assessment Methodology

12.4.1 Approach

12.4.1.1 Assumptions and limitations

No intrusive archaeological investigations have been undertaken. The information available as a result of desk-based work and site walk-over surveys is considered sufficient for all assets for the purposes of assessment.

While archaeological sites are identified in the Al Jouf Province by the Saudi Commission for Tourism and National Heritage, no information concerning the names, type or date of these sites has been included within available data.

At the time of writing no information was available concerning access routes or compounds/set down areas associated with the construction phase of each site. As a result these have not been considered during assessment.

12.4.1.2 Assessment of value

Based on guidance provided by ICOMOS (2011) and professional judgement an assessment of the value of each heritage asset was undertaken on a six point scale of very high, high, medium, low, negligible and unknown. Individual cultural heritage sites, objects or practices are referred to as heritage assets. Setting; the surroundings in which a place is experienced, its local context, embracing present and past relationships to the adjacent landscape, where relevant, is considered to contribute to the value of heritage assets.

Criteria to assess the value of heritage assets are presented in Table 12-1.

Table 12-1: Criteria to Assess the Value of Heritage Assets

	IFC Category			
	Tangible	**Tangible**	**Unique tangible features or tangible objects**	**Intangible forms of culture**
ICOMOS Grading:	*Archaeology*	*Built heritage or Historic Urban Landscape*	*Historic landscape*	*Intangible cultural heritage or associations*
Very High	Sites of acknowledged international importance inscribed as World Heritage (WH) property. Individual attributes that convey Outstanding Universal Value (OUV) of the WH property. Assets that can contribute significantly to acknowledged international research objectives.	Sites or structures of acknowledged international importance inscribed as of universal importance as WH property. Individual attributes that convey OUV of the WH property. Other buildings or urban landscapes of recognized international importance.	Landscapes of acknowledged international importance inscribed as WH property. Individual attributes that convey OUV of the WH property. Historic landscapes of international value, whether designated or not. Extremely well-preserved historic landscapes with exceptional coherence, time-depth or other critical factors.	Areas associated with Intangible Cultural heritage (ICH) activities as evidenced by the national register. Associations with particular innovations, technical or scientific developments or movements of global significance. Associations with particular individuals of global importance.
High	Nationally designated Archaeological Monuments protected by the State Party's laws. Undesignated sites of the quality and importance to be designated. Assets that can contribute significantly to acknowledged national research objectives.	Nationally designated structures with standing remains. Other buildings that can be shown to have exceptional qualities in their fabric or historical associations not adequately reflected in the listing grade. Conservation Areas containing very Important buildings. Undesignated structures of clear national importance.	Nationally designated historic landscape of outstanding interest. Undesignated landscapes of outstanding interest. Undesignated landscapes of high quality and importance, and of demonstrable national value. Well preserved historic landscapes, exhibiting Considerable coherence, time-depth or other critical factors.	Nationally designated areas or activities associated with globally important ICH Activities. Associations with particular innovations, technical or scientific developments or movements of national significance. Associations with particular individuals of national importance.
Medium	Designated or undesignated assets that can contribute significantly to regional research objectives.	Designated buildings. Historic (unlisted) buildings that can be shown to have exceptional qualities or historical associations. Conservation Areas containing buildings that contribute significantly to its historic character. Historic townscapes or built-up areas with important historic integrity in their buildings, or built settings.	Designated special Historic landscapes. Undesignated historic landscapes that would justify special historic landscape designation. Landscapes of regional value. Averagely well preserved historic landscapes with reasonable coherence, time-depth or other critical factors.	With ICH activities as evidenced by local registers. Associations with particular innovations or developments of regional or local significance. Associations with particular individuals of regional importance.
Low	Designated or undesignated assets of local importance. Assets compromised by poor preservation and/or poor survival of contextual associations. Assets of limited value, but with potential to contribute to local research objectives.	"Locally Listed" buildings. Historic (unlisted) buildings of modest quality in their fabric or historical associations. Historic Townscape or built-up areas of limited historic integrity in their buildings, or built settings.	Robust Undesignated historic landscapes. Historic landscapes with importance to local interest groups. Historic landscapes whose value is limited by poor preservation and/or poor survival of contextual associations.	ICH activities of local significance. Associations with particular individuals of local importance. Poor survival of physical areas in which activities occur or are associated
Negligible	Assets with little or no surviving archaeological interest.	Buildings or urban landscapes of no architectural or historical merit; buildings of an intrusive character.	Landscapes little or no significant historical interest.	Few associations or ICH vestiges surviving.
Unknown	The importance of the asset has not been ascertained.	Buildings with some hidden (i.e. inaccessible) potential for historic significance.	n/a	Little is known or recorded about ICH of the area.

12.4.1.3 Assessment of magnitude of impact

Magnitude of impact is the degree of change that would be experienced by an asset and its setting if the proposed scheme was completed, as compared with a 'do-nothing' situation. Magnitude of impact is assessed without reference to the value of each asset, and may include physical impacts on the asset or impacts on its setting or amenity value. The assessment of magnitude was undertaken using professional judgement guided by the criteria presented in ICOMOS (2011). Criteria for defining magnitude of impact are presented in Table 12-2. Unless otherwise stated, all impacts are adverse.

Table 12-2: Criteria to Assess Magnitude of Impact on Tangible and Intangible Heritage Assets

	IFC Category			
	Tangible	**Tangible**	**Unique tangible features or tangible objects**	**Intangible forms of culture**
ICOMOS Impact Grading:	*Archaeological attributes*	*Built heritage or Historic Urban Landscape attributes*	*Historic landscape attributes*	*Intangible cultural heritage attributes or associations*
Major	Changes to attributes that convey OUV of WH properties. Most or all key archaeological materials, including those that contribute to OUV such that the resource is totally altered. Comprehensive changes to setting.	Change to key historic building elements that contribute to OUV, such that the resource is totally altered. Comprehensive changes to the setting.	Change to most or all key historic landscape elements, parcels or components; extreme visual effects; gross change of noise or change to sound quality; fundamental changes to use or access; resulting in total change to historic landscape character unit and loss of OUV.	Major changes to area that affect the ICH activities or associations or visual links and cultural appreciation.
Moderate	Changes to many key archaeological materials, such that the resource is clearly modified. Considerable changes to setting that affect the character of the asset.	Changes to many key historic building elements, such that the resource is significantly modified. Changes to the setting of an historic building, such that it is significantly modified.	Change to many key historic landscape elements, parcels or components; visual change to many key aspects of the historic landscape; noticeable differences in noise or sound quality; considerable changes to use or access; resulting in moderate changes to historic landscape character.	Considerable changes to area that affect the ICH activities or associations or visual links and cultural appreciation.
Minor	Changes to key Archaeological materials, such that the resource is slightly altered. Slight changes to setting.	Change to key historic building elements, such that the asset is slightly different. Change to setting of an historic building, such that it is noticeably changed.	Change to few key historic landscape elements, parcels or components; slight visual changes to few key aspects of historic landscape; limited changes to noise levels or sound quality; slight changes to use or access; resulting in limited change to historic landscape character.	Changes to area that affect the ICH activities or associations or visual links and cultural appreciation.
Negligible	Very minor changes to key archaeological materials, or setting.	Slight changes to historic building elements or setting that hardly affect it.	Very minor changes to key historic landscape elements, parcels or components; virtually unchanged visual effects; very slight changes in noise levels or sound quality; very slight changes to use or access; resulting in a very small change to historic landscape character.	Very minor changes to area that affect the ICH activities or associations or visual links and cultural appreciation.
No change	No change.	No change to fabric or setting.	No change to elements, parcels or components; no visual or audible changes; no changes in amenity or community factors.	No change

12.4.1.4 Assessment of significance of effect

For tangible and intangible heritage assets, the significance of effect was determined as a combination of the value of the asset and the magnitude of impact. This was achieved using professional judgment informed by the matrix presented in Table 12-3. Five levels of significance of effect are defined; neutral, slight, moderate, large and very large. Unless otherwise stated all effects are adverse.

Table 12-3: Matrix to Assess the Significance of Effects on Heritage Assets

Magnitude of Impact / Value	No change	Negligible	Minor	Moderate	Major
Very High	Neutral	Slight	Moderate / Large	Large / Very Large	Very Large
High	Neutral	Slight	Moderate / Slight	Moderate / Large	Large / Very Large
Medium	Neutral	Neutral / Slight	Slight	Moderate	Moderate / Large
Low	Neutral	Neutral / Slight	Neutral / Slight	Slight	Slight / Moderate
Negligible	Neutral	Neutral	Neutral / Slight	Neutral / Slight	Slight
Unknown	Neutral	Neutral	Neutral	Neutral	Neutral

12.4.1.5 A ‘chance find’ procedure

IFC Performance Standard 8 states that:

“The client is responsible for siting and designing a project to avoid significant damage to cultural heritage. When the proposed location of a project is in areas where cultural heritage is expected to be found, either during construction or operations, the client will implement chance find procedures established through the Social and Environmental Assessment. The client will not disturb any chance finds further until an Assessment by a competent specialist is made and actions consistent with the requirements of this Performance Standard are identified.”

The assessment of impact has assumed that a chance find procedure will be implemented during the construction phase of the Park, in order to identify any previously unrecorded archaeological sites or un-stratified archaeological finds. This procedure will be outlined and included within the Environmental Monitoring and Management Plan.

12.4.1.6 SCTA Exclusion Requirements

In accordance with Article 46 of the national Antiquities, Cultural Heritage and Museum Regime, the SCTA has stated that there should be no construction within 200m of the assets. To confirm, the nearest turbine is located in excess of 1km from these assets, and similarly there are no known construction activities within 1km. The assessment of impact has considered the implementation of this exclusion zone to safeguard these assets.

12.5 Impact Assessment

12.5.1 Construction Phase Impacts

Impacts identified during assessment resulting from construction include the removal of buried archaeological remains and un-stratified archaeological finds. Impacts are described in Table 12-4.

Table 12-4: Construction Phase Archaeological & Cultural Heritage Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
CH01	Previously Undiscovered Cultural Heritage Assets	Low	Partial or total removal of any unknown buried archaeological remains or un-stratified archaeological finds,	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Rare Duration: Short Extent: Local Permanence: Reversible	Low	Low

12.5.2 Partial or total removal of any unknown buried archaeological remains or un-stratified archaeological finds

Construction of the proposed scheme would require the installation of up to 130 Wind Turbine Generators (including foundations and a remote terminal unit), a Switching Station, a Substation and a communication and server room. Construction would result in the partial or total removal of any unknown buried archaeological remains or un-stratified archaeological finds within the study area. The magnitude of this temporary impact has been assessed to be minor and the significance of effect to be slight.

Impact CH01 – Low Significance

12.5.3 Operation Phase

Operation of the scheme is not predicted to result in any effects on identified heritage assets.

12.5.4 Decommissioning Phase

The decommissioning of the scheme is not predicted to result in any effects on identified heritage assets.

12.6 Mitigation & Requirements

No impacts of moderate or high significance have been recorded, and there is no requirement for mitigation. It is recommended that the following Good International Industry Practice (GIIP) is implemented:

12.6.1 Mitigation by design

The siting of compounds and access routes relating to the development site must take into account the presence of the historic Hajj route.

12.6.2 Consultation

IFC Performance Standard 8 states that:

"Where a project may affect cultural heritage, the client will consult with affected communities within the host country who use, or have used within living memory, the cultural heritage for longstanding cultural purposes to identify cultural heritage of importance, and to incorporate into the client's decision-making process the views of the affected communities on such cultural heritage. Consultation will also involve the relevant national or local regulatory agencies that are entrusted with the protection of cultural heritage."

It is therefore recommended that further consultation with Saudi Commission for Tourism and Antiquities is undertaken by the IPP during the next phase of development. Following consultation during this phase of the project, the SCTA has recommended that regular site inspections are undertaken during the construction phase of the development to ensure there are no adverse impacts. The SCTA has also recommended that the sites are fenced, interpretation is installed and the tracks to the sites are paved to improve access.

12.6.2.1 Site inspection

A site inspection is recommended for all proposed schemes in advance of construction in order to identify any previously unrecorded archaeological sites and / or un-stratified archaeological finds.

12.7 Conclusion

This Cultural Heritage assessment has been based on a precautionary approach using data from desk-based review and current available design assumptions. As the design progresses and more details become available, the impact assessment may have to be re-visited if significant alterations are made to the design, with any updates reported in an Addendum to this ESIA.

Due to the nature of the site and the location of previous discovered archaeological remains, it is considered highly unlikely that further high value remains will be disturbed as a consequence of the introduction of the Park, especially given the low intrusivity of the groundworks.

The ‘chance find’ procedure is expected to sufficiently protect any high value assets which may be discovered during the construction, operation and decommissioning of the Park.

12.8 References

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13. Traffic & Transport Infrastructure

13.1 Introduction

The purpose of this chapter is to describe the existing traffic and transport infrastructure of the development site and surrounding area, identify future plans for expansion, and assess the potential impact of the Dumat Al Jandal Wind Energy Park (the 'Park') on existing and planned transport infrastructure.

Potential impacts from traffic and transport on other aspects of the environment are addressed in the relevant sections of this report as follows:

- Chapter 6 – Air Quality and Meteorology;
- Chapter 9 – Noise and Vibration;
- Chapter 14 – Socio-economic; and,
- Chapter 17 – Health and Safety.

13.2 International and National Standards and Guidance

13.2.1 IFC General EHS Guidelines

Section 3 *Community Health and Safety* of the IFC General EHS Guidelines (IFC, 2007) provides guidelines for the management of traffic safety during the construction and operation phases of a project and includes the operation of project equipment on private or public roads and all project personnel while commuting to and from the workplace. Section 3 states that the prevention and control of traffic related injuries and fatalities should include the adoption of safety measures that are protective of project workers and of road users, including those most vulnerable to road traffic accidents (IFC, 2007).

Section 3 recommends measures to improve traffic safety, including collaboration with local communities and responsible authorities and coordination with emergency responders.

Section 4 *Construction and Decommissioning* of the IFC General EHS Guidelines (2007) recognizes that construction activities may result in a significant increase in movement of heavy vehicles for the transport of construction materials and equipment, increasing the risk of traffic related accidents. It states that increased risk of traffic-related accidents to workers and local communities should be minimized through a combination of education and awareness raising, and the adoption of procedures identified in Section 3 Community Health and Safety of the IFC General EHS Guidelines (IFC, 2007).

13.2.2 IFC EHS Guidelines for Wind Energy

Section 1.3 *Community Health and Safety* of the IFC EHS Guidelines for Wind Energy (2015) recognizes the challenges associated with the transportation of oversized or heavy wind turbine components (i.e. blades, turbine tower sections, nacelle, transformers) and cranes to the site. It is recommended that a logistics, traffic and transportation study is undertaken and that this should assess impacts on existing offsite roadways, bridges, crossing over culverts, overpasses / underpasses, turning radii and utilities as well as whether surface replacements, upgrades or resettlements will be required (IFC, 2015).

The guidelines recommend that in order to reduce delays to other road users and the potential for other effects on local communities in the vicinity of the proposed route, schedule deliveries outside of peak hours, use only approved access routes, provide traffic management to stop other traffic where needed and provide police escorts where required (IFC, 2015). It is implicit in the guidelines that engagement and consultation with stakeholders and Affected Communities is integral to the development of the final logistics, traffic and transportation plan.

13.2.3 IFC Performance Standard 4: Community Health and Safety

This performance standard outlines ways in which communities and individuals may be affected by project activities, through increased exposure to risk and impacts arising from equipment accidents, structural failures and the release of hazardous materials.

With regard to risk associated with traffic and transport, this Performance Standard highlights the risk to associated communities arising from the disruption of local roads and infrastructure resulting from the transport of construction materials and turbine components to and from the Park.

The Performance Standard requires that *"The client will evaluate the risks and impacts to the health and safety of the Affected Communities during the project life-cycle and will establish preventive and control measures consistent with good international industry practice (GIIP), 1 such as in the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) or other internationally recognized sources. The client will identify risks and impacts and propose mitigation measures that are commensurate with their nature and magnitude. These measures will favor the avoidance of risks and impacts over minimization."*

This emphasizes the requirement for the IPP to prepare and implement a comprehensive traffic management plan for the construction and decommissioning of the Park.

13.2.4 National Legislation

13.2.4.1 Ministry of Transport

13.2.4.1.1 "Exceptional Loads" 01-77, dated 7-5-1432 (corresponding to 7th May 2011)

This document outlines the MOT permitting requirements for transporting exceptional loads and the specifications which constitute such a load. Requirements are laid out which must be fulfilled in order to obtain a permit. These include:

- Specifications of vehicles.
- Description of the load to be transported.
- The pre-submission time required to obtain a permit.
- The standard also outlines commitments which must be met by the driver of the vehicle. These include:
- Commitment to follow the pre designated and approved route.
- Commitment to adhere to a pre designated and approved speed limit.

Permits, once issued, are valid for one trip, must be used during daytime hours only, and may not be used over weekends or public holidays.

13.2.4.2 Saudi Ports Authority Rules and Regulations

The Saudi Ports Authority Rules and Regulations include guidance on the safe operation and control of activities within ports, including loading and unloading, environmental protection, port safety and security and the fair treatment of workers.

13.3 Baseline Environmental Conditions

13.3.1 National Airport Infrastructure

The Kingdom of Saudi Arabia has four international airports; the King Abdulaziz International airport in Jeddah, the King Khalid International airport north of Riyadh, the Prince Mohammad Bin Abdulaziz International airport in Madinah, and King Fahd International airport at Dammam.

Air travel represents the fastest means of transport between the large towns and cities of the Kingdom of Saudi Arabia, with a total of 29 civilian airports spread across the country. Military airports and a number of airports owned by Saudi Arabian Oil Company (Saudi Aramco) are also found throughout the country. All airports in Saudi Arabia are under the control of the General Authority of Civil Aviation (GACA). The Statistical Yearbook for 2015 reported 466,332 flights from international airports (including both departures and arrivals) carrying 65,941,677 passengers and 116,907 flights from domestic airports carrying 13,049,478 passengers over the course of the year (GACA, 2017).

13.3.2 National Rail Infrastructure

Rail is the least developed means of transportation in the Kingdom of Saudi Arabia, and consists primarily of a single track, standard-gauge line. The Saudi Railways Organization (SRO) and the Saudi Arabian Railways (SAR) are the two state-owned railway companies in The Kingdom of Saudi Arabia that operate Saudi Arabia's passenger and freight network. The national network is shown on Figure 13-1. The green line is operated by SAR while the remaining lines are operated by the SRO.

There are a number of expansion programs currently under review and construction, led by the SRO. Expansion of the railway network is being undertaken through the development of a Saudi Railway Master Plan 2010-2040, which will be implemented in three stages of development. Projects that are part of the first stage of development include:

- The North South Railway Line is a 2,750 kilometers railway project by SAR. It is comprised of two lines, the first of which runs from Riyadh to the north-west of the Kingdom of Saudi Arabia and the city of al Haditha on the Jordanian border. This line includes new stations in the towns of Majmaa, Qasim, Hail, Jouf, and Quriyyat. The second line starts from Al Jalamid mine and the ‘Mining City of the North’ located in the north-east of the Kingdom of Saudi Arabia, and runs through Al Jouf and Hail until it arrives at Al Baithah Railway junction in Qassim region. From Qassim it then heads to the port and export facilities at Ras al Khair. This line was opened in 2011 and enables phosphoric acid, sulfur and other products manufactured in the mining city to be freighted for export.
- The Haramien high speed railway connecting Makkah – Jeddah – Madinah is in the final stages of testing and commissioning. This project includes four new passenger stations in Makkah, Medina, Jeddah, King Abdullah Economic City in Rabigh and a fifth station at King Abdulaziz International Airport within the airport development project.
- The planned land bridge between Riyadh and Jeddah (West Bridge Rail Project) and between Dammam and Jubail; the connection between Dammam and Jubail was due for completion in 2016 although it has not yet been constructed. Construction of the land bridge between Riyadh and Jeddah is yet to commence.

The Gulf Cooperation Council (GCC) countries are currently working in partnership to develop a regional high speed rail network. The proposed alignment of the high speed network will extend from Kuwait to Dammam in the Kingdom of Saudi Arabia; from Dammam to the Kingdom of Bahrain across a proposed causeway parallel to the existing King Fahd Causeway; from Dammam to Qatar via Salwa Port; and the State of Qatar to the Kingdom of Bahrain via the proposed Qatar-Bahrain Bridge. Eventually the network will extend to Muscat in Oman. The total length of these lines is approximately 2,116 km and the length of the line within Saudi Arabia is 663 km (www.saudirailways.org).

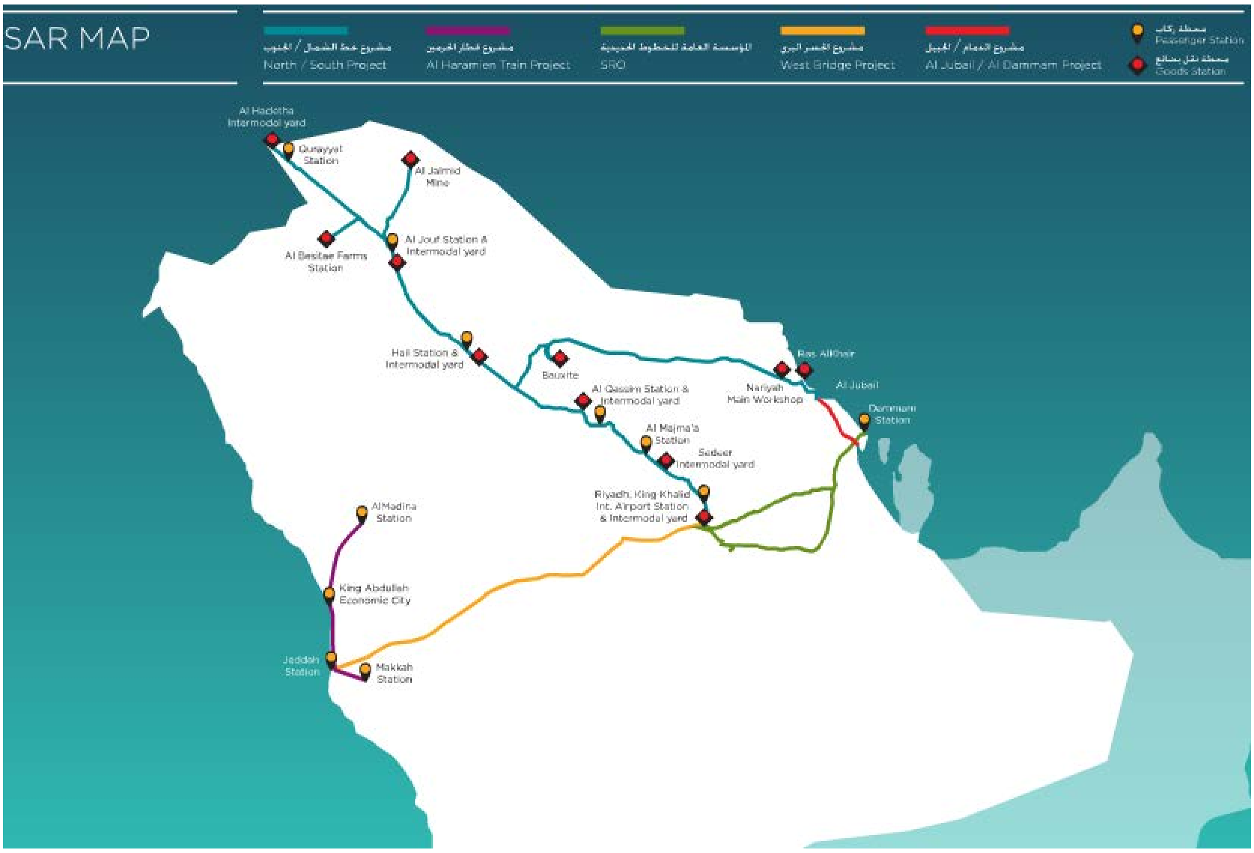

Figure 13-1: Rail Network in the Kingdom of Saudi Arabia

13.3.3 National Road Infrastructure

The Ministry of Transport (MOT) is responsible for the design, build and maintenance program of new and existing roads, as well as the coordination of all surface transport services, including rail and bus. Due to large scale growth in the petroleum, petrochemical and agricultural sectors, and rapid development of urban cities, the road network of the Kingdom of Saudi Arabia has significantly improved in recent years. In order to alleviate congestion in cities, caused by the increase in traffic, a number of cities have been upgraded and connected with a modern road network (SAMIRAD, 2015).

SAPTCO is a leading national bus service provider, offering affordable public transport inside and outside the Kingdom. It operates a fleet of 4,500 buses carrying out 800 daily scheduled trips during low seasons and 1,000 trips in high seasons (SAPTCO, 2015).

SAPTCO operates a network of intercity buses, connecting more than 385 cities, villages, and small villages throughout the Kingdom. The intercity route covers the main five cities; Riyadh, Mecca, Madinah, Jeddah, and Dammam. SAPTCO has expanded its services from national to international level, providing a gateway to the United Arab Emirates, Bahrain, Qatar, Kuwait, Egypt, Jordan, Yemen, and Sudan (SAPTCO, 2015).

13.3.4 National Port Infrastructure

The Saudi Ports Authority (SPA) was established in 1997 with the key responsibilities of handling day to day port management affairs, operation, and maintenance work, and to serve the shipping industries (SPA, 2014). There are six commercial ports in the Kingdom of Saudi Arabia situated at Jeddah, Dammam, Jizan, Dhiba, Jubail and Yanbu; three industrial ports are well established in the eastern province; Jubial (King Fahd Industrial Port), Dammam (King Abdulaziz Port) and Jubail commercial port (SPA, 2014).

13.3.5 Regional and Local Airport Infrastructure

Al Jouf International Airport is located approximately 25 km to the south-east of the development site. This international airport which serves Sakaka, Dumat Al Jandal and Al Jouf was established in 1974 although it has recently been extended. It is comprised of a single terminal and has a passenger handling capacity of 175,000 (www.gaca.gov.uk).

There are military assets located in the immediate vicinity of the airport, although the Ministry of Defense has not provided any detail on the nature of these assets.

The General Authority for Civil Aviation has issued a ‘letter of no objection’ for the development of the Park.

13.3.6 Regional and Local Rail Infrastructure

To the south-west of Dumat al Jandal the North South Railway Line splits into two lines: the first is the line which runs from Riyadh to the north-west of the Kingdom and the city of al Haditha on the Jordanian border; and the second is the line which starts from Al Jalamid mine and the ‘Mining City of the North’ and runs through Al Jouf and Hail until it arrives at Al Baithah railway junction in Qassim region. From Qassim this line runs to the port and export facilities at Ras al Khair.

The line which runs to the Al Jalamid mine and the ‘Mining City of the North’ runs along the western boundary of the Park. Furthermore, there is a rail station and dry-dock facility under construction approximately 32 km to the south of the Park. The Public Transport Authority has confirmed that the center line of the railway is 276m to the west of the boundary of the Park.

13.3.7 Regional and Local Road Infrastructure

Road 80 and Road 65 are the main highway transportation routes in the region and local to the Park. Road 80 traverses the north of the Kingdom of Saudi Arabia from Arar in the north-east to Tabuk in the west, and passes through the towns of Sakaka, Dumat Al Jandal and Al Jouf. Road 65, similarly a dual carriageway, crosses the An Nafud desert and links Al Jouf province with Hail, Qassim and eventually Riyadh. Road 65 also extends up to Qurrayat in the far north-west near to the border with Jordan.

A dual carriageway bypass has recently been constructed which connects Route 65 to the south of the town of Dumat Al Jandal with Route 80 to the north-east of the town of Sakaka. This bypass avoids the town of Sakaka.

There are a number of small roads and un-named roads which connect the local communities and agricultural areas to Road 80 and the bypass. These roads consist of paved highways and informal tracks. Access to the Park is proposed from an un-named road which runs to the south of the Park. This is a single carriageway, sealed road. There is a road which runs north from the town of Dumat Al Jandal towards the southern boundary of the Park before running north-west where it joins the North South Railway Line.

13.3.8 Baseline Traffic survey

Jacobs ZATE was commissioned in 2015 to undertake a traffic study to assess the road safety and traffic impacts of bulk fuel distribution by trucks at 9 of Saudi Aramco’s 22 bulk plants across the Kingdom. The Al Jouf bulk plant located approximately 30 km south east of the development site was included in this study.

Road 80 is anticipated to be one of the main routes utilized for the transport of turbine components to the development site, and is considered broadly representative of roads within the area surrounding the development site.

The objectives of the study were to:

- Evaluate the existing traffic conditions and issues raised by bulk plant operators.
- Evaluate the predicted future traffic conditions, based on traffic growth and expansion of the road network.

- Propose short and long term alternative solutions, and recommend a preferred solution.

This survey was conducted on Road 80 using standard methodology, automated traffic count devices, video and 'tube counters' in order to accurately record the number of vehicles travelling past the survey location within a 24 hour period. The results from this previous survey will be utilized and no further survey work will be carried out.

Baseline traffic data was collected during 2015 using 2 automated traffic counts (ATC) and 4 turning movement counts (TMC). The location of the survey locations are shown on Figure 13-2 and described in Table 13-1.

Figure 13-2: Baseline Traffic Survey Locations (Source: Jacobs ZATE, 2016)

Table 13-1: Traffic Survey Locations

Ref. No.	Location	Type	Date	Duration
1	Highway 80 U-turn	Turning	13-14 April 2015	12
2	Highway 80 at Azfaa Road	Turning	13-14 April 2015	12
3	Bulk Plant Access	Turning	13-14 April 2015	12
4	Highway 80	Volume + Speed	13-14 April 2015	24
5	Highway 80 U-turn	Turning	13-14 April 2015	12
6	Azfaa Road	Volume + Speed	13-14 April 2015	24

13.3.8.1 Automated Traffic Count Data

The ATC data collected was used to provide a continuous flow profile allowing the highway network peak hours to be determined. From the analysis, the public network peak periods are:

- AM Peak – 07.00 – 08.00.
- PM Peak – 14.00 – 15.00.

The traffic volume flow profile for both north and southbound directions on Highway 80 and the Azfaa Road is shown in Figure 13-3.

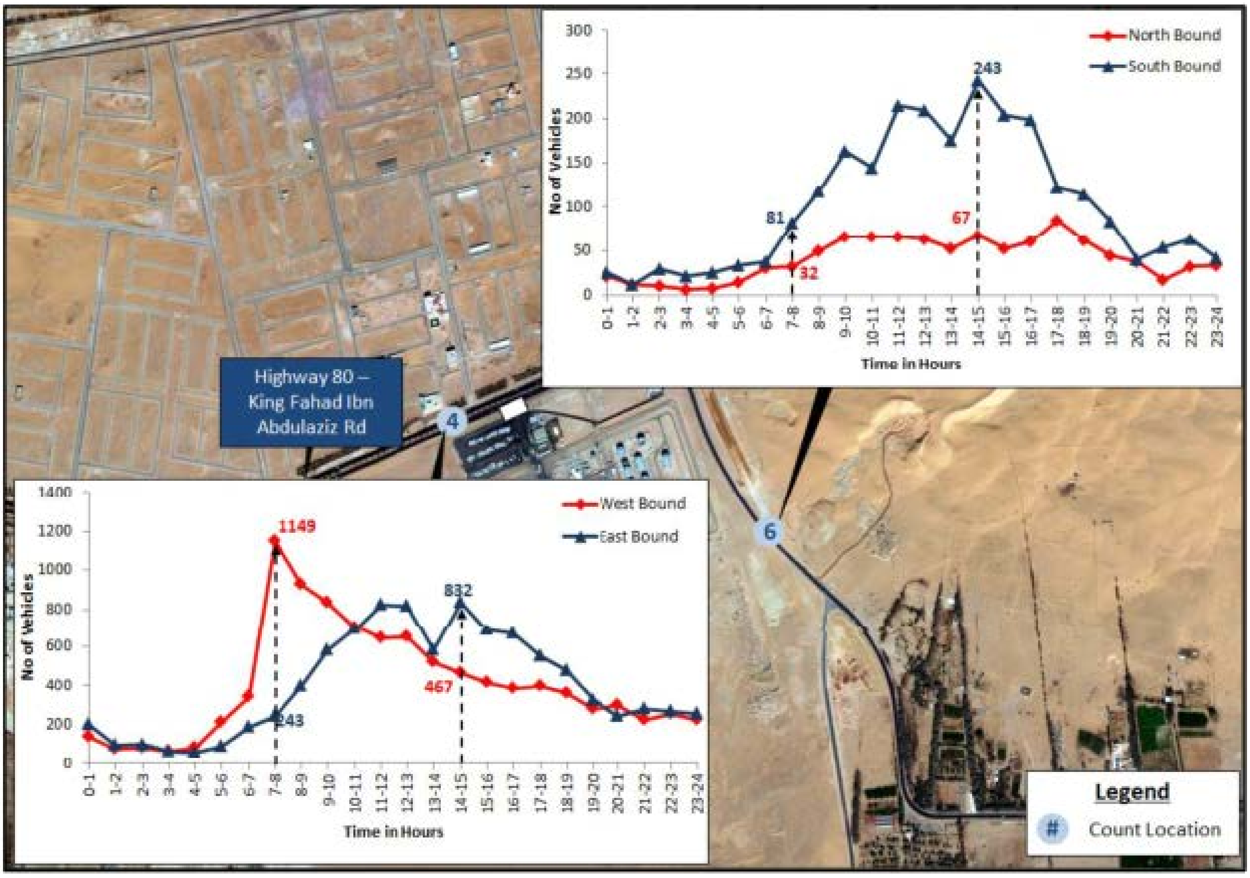

Figure 13-3: Traffic Volumes on Highway 80 and Azfaa Road

13.3.8.2 Turning Movement Count (TMC) Data

The TMC data collected is illustrated on Figure 13-4. The AM and PM peak periods are:

- AM Peak – 07.00 – 08.00.
- PM Peak – 14.00 – 15.00.

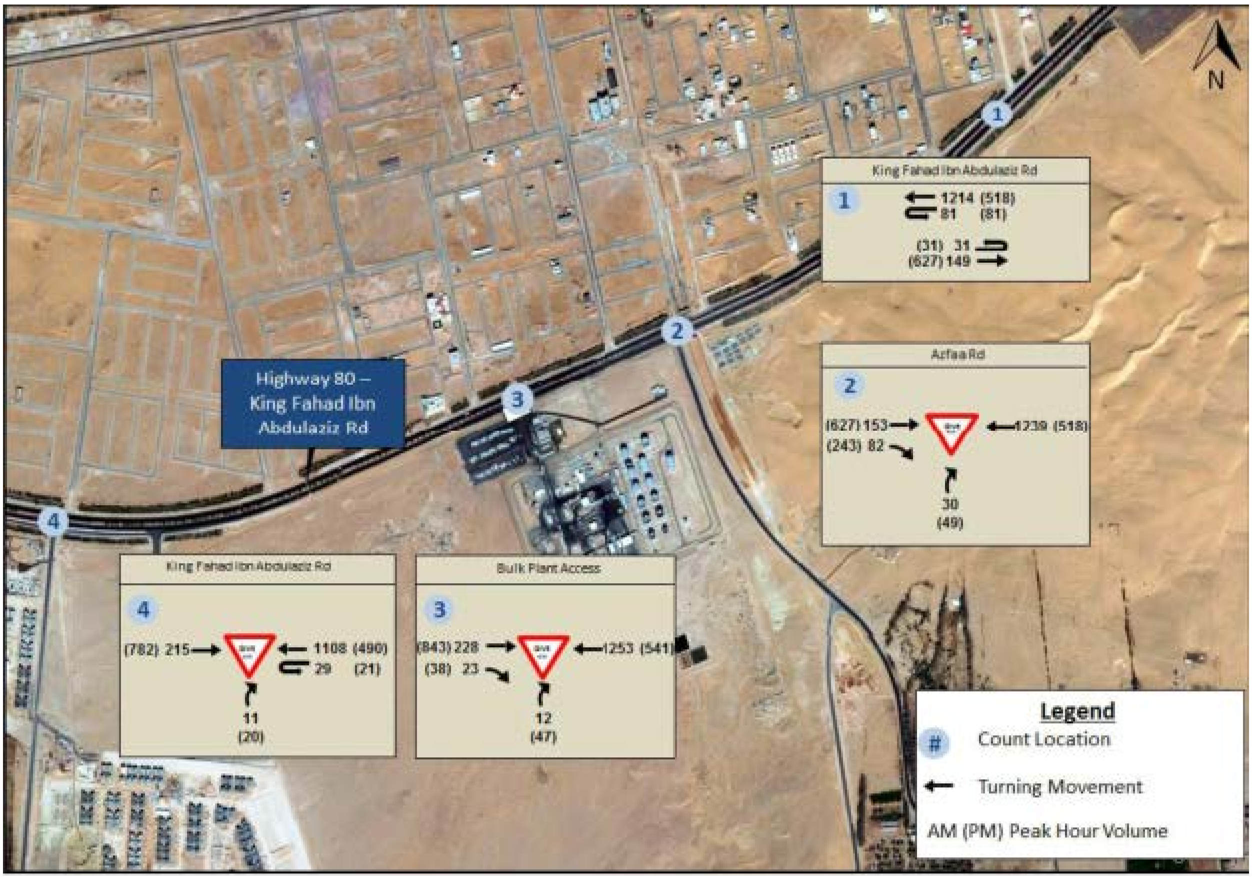

Figure 13-4: AM and (PM) Peak Hour Turning Movement Counts – Highway 80 Interchapters

As can be seen in Figure 13-4 the busiest flows in the AM and PM peak hours are the highway 80 through movements where there are approximately 1250 westbound in the AM peak and approximately 850 eastbound in the PM peak.

13.3.8.3 Observed and Peak Demand

According to demand data supplied by Saudi Aramco there are approximatyely 410 trucks arriving and departing the bulk plant each day. During the peak hours of the day there are approximately 27 trucks arriving and departing the bulk plant. This data complements the traffic survey data undertaken by Jacobs ZATE which indicated approximately 33 trucks arriving and departing during the peak hours of the day.

Future demand data indactes that by 2040 there will be approximately 670 trucks arriving and departing per day. The peak hours of which will have approximately 45 trucks arriving and departing the bulk plant.

13.3.8.4 Road Capacity

Level of Service (LOS) analysis is a system of measurement used to quantify the capacity of road networks to provide an indication of how ‘free flowing’ traffic is at a particular location.

Existing 2015 Synchro modelling was undertaken to assess the capacity of the surrounding interchapters during the AM and PM peak periods. The Synchro modelling indicated that the existing interchapters all operate with LOS values of A during both the AM and PM peak periods. LOS A indicates freely moving traffic and therefore, a road operating within capacity. The recommendations for the bulk plant are centered on safety improvements only as Highway 80 is operating within design capacity for both current and future demand.

13.3.9 Supplementary Baseline Survey

A further traffic survey was carried out on the local road network to the south of the Park to ascertain the levels of service and traffic volumes. The un-named road to the north of the town of Dumat Al Jandal was surveyed on 14th December 2016 and the location of the survey is illustrated on Figure 13-5. The traffic survey was conducted over a four hour duration (two hours in the morning and two hours in the afternoon), and the results recorded and tabulated.

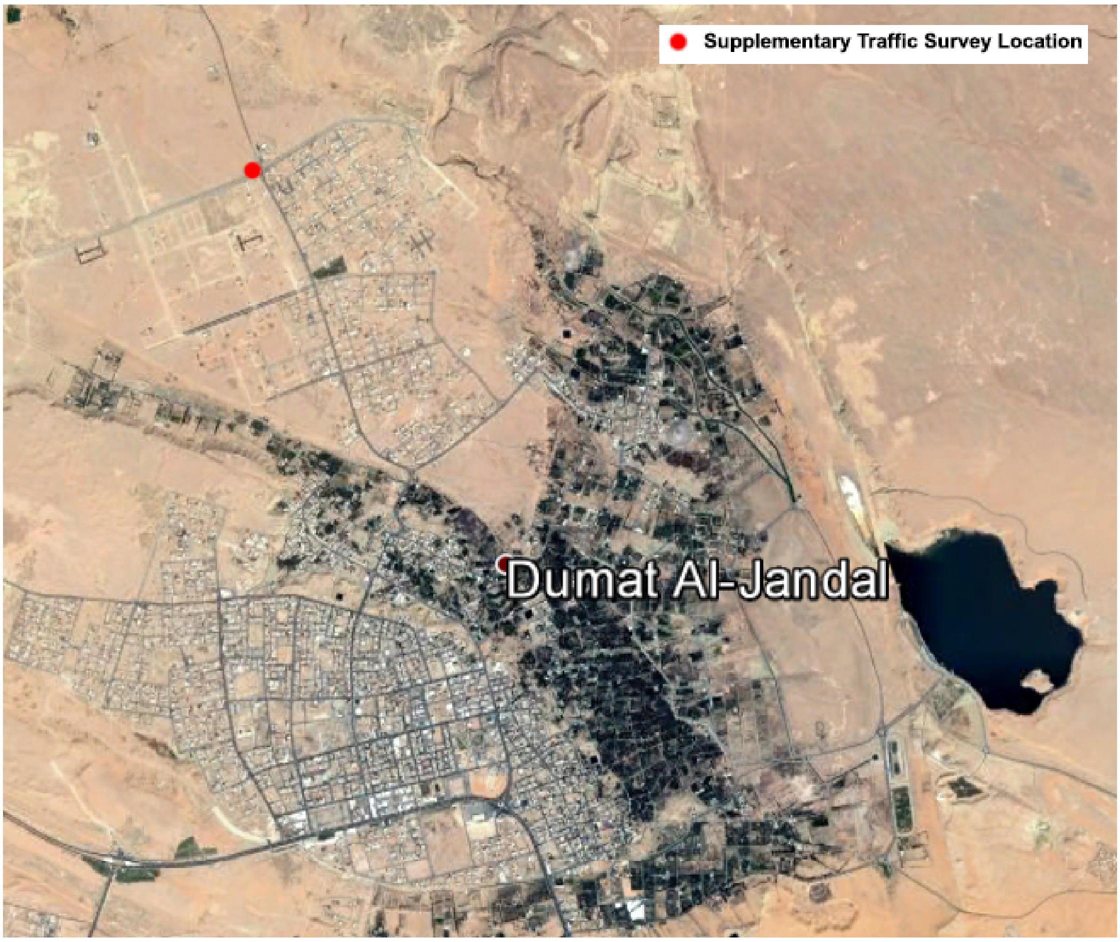

Figure 13-5: Supplementary Traffic Survey Location

The results of the traffic survey are show in Table 13-2. The results show that the un-named road to the north of the town of Dumat Al Jandal experiences a very low volume of traffic both during the day and the evening. The majority of vehicles are pick-ups, and cars. The unnamed road leads to the scattered farming settlements to the north of Dumat Al Jandal; the routes then deteriorate into informal tracks further north.

Table 13-2: Traffic Survey Data

Survey Date	Direction	Car		Bus		Pick-up/Van		Truck		Total	
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
December 14, 2016	Eastbound	6	13			7	12			38	
	Westbound	7	7			20	8			42	

13.3.10 Transportation of Turbine Components

At this stage of the design, the suppliers of the equipment (e.g. blades, turbine tower sections, nacelle, transformers) have not yet been identified and the transportation route for equipment to the development site has not yet been confirmed. The IPP will be responsible for preparing a logistics, traffic and transportation plan following the identification of the preferred suppliers of equipment.

In the interim, the preliminary design for the Dumat Al Jandal Wind Energy Park prepared by DNV GL (2017) includes a high level consideration of transportation routes. It has been assumed that components will be transported by sea from Jubail Port in the Eastern Province. DNV GL has then considered transportation by road from this point of entry.

DNV GL has identified that there are three classifications of road that will be utilized during the transportation of equipment from the point of entry by sea to the development site. These are:

- "Public road" refers to any road which is maintained by the local authorities and is in common use by the travelling public, in urban or rural areas.
- "Access road" refers to a road, existing or purpose-built, which leads from any public road system to the site.
- "Site road" refers to any road built to carry traffic from the site entrance to the crane pads.

In order to be considered suitable for the transportation of turbines, DNV GL has specified that roads must exhibit the following characteristics at a minimum:

- Load capacity: the load bearing capacity of all site roads must be no less than 15 tons per axle; Permission must be sought to use all roads and bridges with the required vehicles.
- Road width: The width of the roads has to be at minimum 5 m. A hindrance free horizontal space of 7 m is required (e.g. no fences, trees, walls etc.).
- Overhead clearance: All roads must be clear of overhead obstructions, i.e. power lines, to a minimum height of 5 m to allow the passage of high loads. The highest part that has to be transported is the first section of the tower. It is noted that all overhead obstructions must be clearly marked with bunting and a gauge to indicate maximum height.
- Slope and grade: The maximum slope of asphalt roads must be lower than 12 %. Slopes in excess of 12 % are subject to approval by the turbine manufacturer, the transporter and the crane company. Special arrangements for towing vehicles can be made in this case. The maximum lateral grade must not exceed 2 °.
- Minimum longitudinal radius (convex or concave): 200 m as a minimum, to avoid the risk of grounding or dragging.
- Minimum inner and outer curve radius: 50 m as a minimum. This could be reduced if an excess width inside and outside the road is granted.

13.3.10.1 Public Roads

The Dumat Al Jandal Wind Farm Preliminary Design Assessment prepared by DNV GL states that a road survey must be conducted by the preferred bidder and the chosen route must be cautiously examined to ensure that abnormal loads and dimensions can go through without difficulty. A traffic management plan must be drafted for approval by local authorities. It is noted that dismantling overbuilding of traffic islands, street light, traffic signs, crash barriers, etc. will be needed, which may lead to delays in the planned delivery and additional costs (DNV GL, 2016).

The following list highlights the key components that the route survey and traffic management plan must cover:

- Use detailed maps (a minimum resolution of 1:25000);
- Axle load and gross train weight limits on roads and bridges;

- The radius and road width at curves, bends, junctions and traffic circles;
- The gradient of inclines and declines;
- The horizontal radius of dips and bumps in the road, at bridges and level crossings;
- Width and height under road and railway bridges and viaducts;
- Clearance under overhead lines and gantries;
- Lay-by areas that can be utilized for temporary parking; and,
- Any other obstruction that may restrict the transportation.

Additionally, it should be noted that the weather conditions must be checked regularly as these may influence the viability of the proposed route.

At present, it is understood that turbine components would be brought into the Kingdom of Saudi Arabia from a variety of locations. For example, towers could be sourced from China and blades/nacelles could be sourced from Europe. At this stage it has been assumed that components will be delivered to Jubail Port. The Port of Jubail is located approximately 1,500 km east of the development site. The anticipated routes to the development site, and their elevation profiles are shown in Figure 13-6.

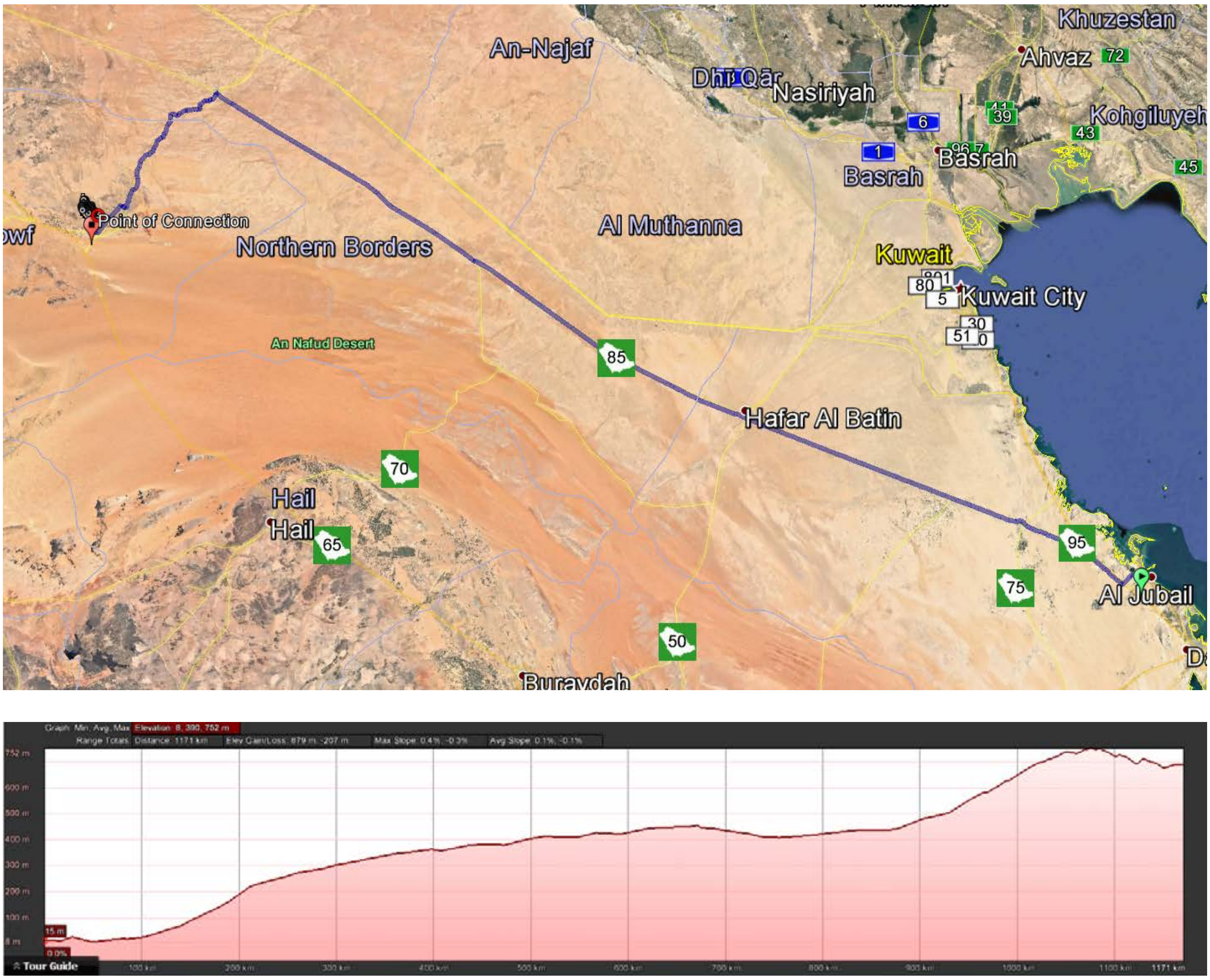

Figure 13-6: Predicted Route from Jubail to the Development Site and Elevation Profile (Vertical Axis Exaggerated)

It should be noted that the route shown accounts only for the transport from the point of entry to the Kingdom of Saudi Arabia, to the development site, and does not account for specific access requirements. There will be a requirement for the IPP (during the detailed design phase of the development) to carry out a comprehensive transportation analysis and a detailed investigation into the most efficient methods for delivering the turbines to their final locations on the development site. Included in this report should be a detailed analysis of sensitive receptors such as schools, places of worship, and other receptors which could potentially be affected by changes to the flow of traffic in proximity to them.

A preliminary list of receptors are identified for the main transportation route (Table 13-3), and these will need to be reviewed by the IPP during the next phase of development and once the preferred transportation route has been identified.

Table 13-3: Potential Sensitive Receptors Located Along Proposed Transportation Route (Jubail - Development Site)

Receptor	Receptor Type	Description	Proximity to Route
Jubail	Major Settlement	Industrial city	>1km
Nairyah	Settlement	Small town with developed infrastructure	>1km
As Salmanyah	Minor Settlement	Small cluster of properties	4km
Al Qaisumah	Minor Settlement	Small town with developed infrastructure	>1km
Ar Rabi	Settlement	Small satellite settlement	4.5km
Al Muhammadiyah	Large town	Three connected smaller settlements with developed infrastructure	>1km
As Sufayri	Small town	Small cluster of occupied and unoccupied properties	10km
Rawdat Habbas	Settlement	Small cluster of properties	>1km
Rafha	Settlement	Small town with airport, hospital and developed infrastructure	>1km
Al Uwayqilah	Settlement	Small partly developed town	>1km
Arar	Small Town	Small town with developed infrastructure	>1km
Zalom	Settlement	Small settlement	>1km
Sakaka	Major Settlement	Large city with developed infrastructure	>1km

13.4 Assessment Methodology

13.4.1 Approach

This Section describes the impact on existing traffic and transport infrastructure as a result of the construction, operation and decommissioning/closure of the proposed Dumat al Jandal Wind Energy Park. The significance of the potential impacts on existing traffic and transport infrastructure are characterized in accordance with standard methodology as described in Chapter 5 of this ESIA.

At this stage of the design, it is not possible to fully assess the potential impact of transporting oversized or heavy wind turbine components to the development site, and the potential impacts on existing offsite roadways, bridges, culverts, overpasses / underpasses, turning radii and utilities; or whether surface replacements, upgrades or resettlements are required. A precautionary assessment has been undertaken and these aspects will be further considered by the IPP during the next phase of design and an addendum to the ESIA will be prepared.

The expected completion date of the nearby railway terminus located approximately 30km south west of the development site boundary is currently unknown, and will be confirmed by the IPP during stakeholder consultation. The railway line is currently used exclusively for freight and it is not clear if the current infrastructure would hold the capacity to be utilized as an alternate means of transportation of turbines. For these reasons, it has been assumed that rail is not a viable means of transportation and therefore has not been considered further in the assessment.

There are no predicted impacts on airport infrastructure during the project life cycle and these receptors have not been considered further.

13.4.2 Recommendations Contained within and EHS Guidance

The assessment of impact assumes that the IFC recommendations for managing traffic and transportation during project development are implemented by the IPP during the construction, operation and decommissioning of the Park.

13.4.2.1 IFC EHS Standard 3.0: Community Health and Safety Section 3.4 – *Traffic Safety*

"Traffic accidents have become one of the most significant causes of injuries and fatalities among members of the public worldwide. Traffic safety should be promoted by all project personnel during displacement to and from the workplace, and during operation of project equipment on private or public roads. Prevention and control of traffic related injuries and fatalities should include the adoption of safety measures that are protective of project workers and of road users, including those who are most vulnerable to road traffic accidents.

Road safety initiatives proportional to the scope and nature of project activities should include:

- *Adoption of best transport safety practices across all aspects of project operations with the goal of preventing traffic accidents and minimizing injuries suffered by project personnel and the public. Measures should include:*
    - *Emphasizing safety aspects among drivers;*
    - *Improving driving skills and requiring licensing of drivers;*
    - *Adopting limits for trip duration and arranging driver rosters to avoid overtiredness ;*
    - *Avoiding dangerous routes and times of day to reduce the risk of accidents; and,*
    - *Use of speed control devices (governors) on trucks, and remote monitoring of driver actions.*
- *Regular maintenance of vehicles and use of manufacturer approved parts to minimize potentially serious accidents caused by equipment malfunction or premature failure.*

Where the project may contribute to a significant increase in traffic along existing roads, or where road transport is a significant component of a project, recommended measures include:

- *Minimizing pedestrian interaction with construction vehicles;*
- *Collaboration with local communities and responsible authorities to improve signage, visibility and overall safety of roads, particularly along stretches located near schools or other locations where children may be present. Collaborating with local communities on education about traffic and pedestrian safety (e.g. school education campaigns);*
- *Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents;*
- *Using locally sourced materials, whenever possible, to minimize transport distances. Locating associated facilities such as worker camps close to project sites and arranging worker bus transport to minimize external traffic; and,*

- *Employing safe traffic control measures, including road signs and flag persons to warn of dangerous conditions*"

13.4.2.2 IFC EHS Standard 4.0: Construction and Decommissioning Section 4.3 - *Community Health and Safety*

Section 4.3 Community Health and Safety of the IFC EHS Guidelines states that projects should implement risk management strategies to protect the community from physical, chemical or other hazards associated with sites under construction and decommissioning. This includes the management of traffic safety and guidelines go on to state:

"Construction activities may result in a significant increase in movement of heavy vehicles for the transport of construction materials and equipment increasing the risk of traffic-related accidents and injuries to workers and local communities. The incidence of road accidents involving project vehicles during construction should be minimized through a combination of education and awareness-raising, and the adoption of procedures described in Section 3.4 (Traffic Safety)."

13.4.2.3 IFC EHS Guidelines for Wind Energy

It is recommended that that a logistics, traffic and transportation study is undertaken and that this should assess impacts on existing offsite roadways, bridges, crossing over culverts, overpasses / underpasses, turning radii and utilities as well as whether surface replacements, upgrades or resettlements will be required (IFC, 2015).

The guidelines recommend that in order to reduce delays to other road users and the potential for other effects on local communities in the vicinity of the proposed route, schedule deliveries outside of peak hours, use only approved access routes, provide traffic management to stop other traffic where needed and provide police escorts where required (IFC, 2015).

13.4.3 General Authority for Civil Aviation

The physical characteristics of wind turbines, coupled with the size and siting of the Park, has the potential for adverse effects on aviation. These include (but are not limited to): physical obstructions; the generation of unwanted returns on Primary Surveillance Radar (PSR); adverse effects on the overall performance of CNS equipment; and turbulence (CAA, 2016).

The potential impacts on radar are considered separately in the Radar Impact Assessment (Appendix K). It is recognized that aircraft wake vortices can be hazardous to other aircraft, and that wind turbines produce wakes of similar, but not identical, characteristics to aircraft. Although there are independent bodies of knowledge for both of the above, currently, there is no known method of linking the two. Published research shows measurements at 16 rotor diameters downstream of the wind turbine indicating that turbulence effects are still noticeable (CAA, 2016; Vermeer *et al,* 2003). To confirm there are no turbines within 16 rotor diameters of the airport in Al Jouf.

The General Authority for Civil Aviation (GACA) has issued a 'conditional letter of no objection' for the development of the Park using 225 m wind turbine generators. Although the Dumat al Jandal Wind Energy Park lies beyond the aerodrome safeguarding limits for Al Jouf, GACA has stipulated that aviation obstructing lighting is installed and that the wind turbines are painted to increase their visual conspicuity.

The Kingdom of Saudi Arabia has not yet developed any specific regulations for managing the development of wind turbine energy parks in proximity to aerodromes, so those developed by the International Civil Aviation Organization (ICAO) and the United Kingdom's Air Navigation Order 2009 as amended have been adopted. In accordance with these regulations, structures away from the immediate vicinity of an aerodrome which have a height of 150 m or more above ground level are:

- Fitted with medium intensity steady red lights positioned as close as possible to the top of the obstacle, and also equally spaced at intermediate levels, so far as practicable, between the top lights and ground level with an interval not exceeding 52 m;

- Illuminated at night, visible in all directions and any lighting failure is rectified as soon as is reasonably practicable; and,

- Painted appropriately: the rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines that are deemed to be an aviation obstruction should be painted white, unless otherwise indicated by an aeronautical study.

The assessment of impact has assumed the implementation of these measures.

13.5 Impact Assessment

13.5.1 Construction Phase

Impacts upon traffic and transportation infrastructure experienced during the construction phase of the development, are likely to relate to the increased volumes of traffic making use of Road 80 and various local roads routes surrounding the development site. Details of the proposed routes from Road 80 to the site access will be confirmed by the IPP during the next phase of development. This traffic is likely to include construction plant and delivery vehicles transporting wind turbines and other infrastructure to the development site (Table 13-4).

Table 13-4: Construction Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TT01	Road Users	Moderate	Traffic congestion and delays	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Frequent Medium Regional Reversible	High	High
TT02	Road Users	High	Road Traffic Accidents	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Local Reversible	High	High
TT03	Road and utility infrastructure	Moderate	Exceedance of operational capacity	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Medium Regional Reversible	High	High

13.5.1.1 Traffic congestion and delays

During the construction of the Park, road traffic associated with the transportation of materials and wind turbine components to site will increase. It is estimated that there will be approximately 8,552 vehicle movements over the 20 month construction period. This includes deliveries of turbine components as well as more standard construction material deliveries, and equates to approximately 14 vehicle movements per day. This material will be transported to the development site along Road 80, and then along unnamed roads to the south of the Park.

Road 80 is currently operating within its design capacity and has capacity for future growth in traffic volumes. A traffic survey of the road running to the north of the town of Dumat Al Jandal towards the southern boundary of the Park indicated very low levels of use. It is not predicted that Road 80 or the local road infrastructure will be adversely affected by vehicles carrying normal loads.

Turbine components are expected to enter the Kingdom of Saudi Arabia via sea to one of the major ports and then be transported via road to the development site. Specialist turbine transportation vehicles will be used and it is likely that there will be a requirement for temporary road closures, diversions and police escorts during the transportation of these components to the development site. Although the transportation of wind turbine components (i.e. blades, turbine tower sections, nacelle, transformers) will be managed as per the requirements of IFC EHS Standard 3.0: *Community Health and Safety* and IFC EHS Standard 4.0: *Construction and Decommissioning*, it is anticipated that impacts will be unavoidable. Temporary road closures, diversions and police escorts are likely to cause disruption and delays to local commuters and road users.

At this stage of the design there remains uncertainty around the scale and character of impacts arising from temporary road closures, diversions and police escorts. In particular, impacts on the local road infrastructure to the south of the Park. In accordance with the precautionary approach, this impact is assessed as high in the absence of mitigation.

Impact TT01 – High Significance

13.5.1.2 Increased number of road traffic accidents

During the construction phase of the Park, it is estimated that there will be approximately 8,552 vehicle movements over the 20 month construction period; this equates to approximately 14 vehicle movements per day. Road 80 is currently operating within its design capacity and capable of handling the additional traffic volume. In terms of vehicle numbers. However, the assessment of capacity is based upon the use of standard vehicles such as sedans, vans, hatchbacks, pickup trucks and HGVs and does not account for the abnormal loads which will be required to transport the turbine components from the ports to the development site. Although 14 vehicles per day is not assessed as significant and local road infrastructure is not predicted to be adversely affected, a precautionary assessment of high has been given due to the sensitive nature of the receptors, and the unknown factors within the traffic and transportation plan (e.g. the use of oversized vehicles in convoy).

Construction traffic will be managed as per the requirements of IFC EHS Standard 3.0: *Community Health and Safety* and IFC EHS Standard 4.0: *Construction and Decommissioning.* This will minimize the potential for impacts to occur as a result of the Park. This includes the development of a logistics, traffic and transportation plan which will cover the transportation of oversized and heavy turbine components using specialist transportation vehicles. Temporary road closures, diversions and police escorts are likely to be required and these will contribute to the management of safety during transportation and limit the risk of collisions and accidents involving specialist transportation vehicles. The management of the transportation of turbines will be carried out in compliance with the relevant permitting requirements of the Ministry of Transport document 1432/5/7 01/77 which requires transportation to be carried out during daytime working hours (i.e. not at night or on weekends or public holidays). The permit also requires that drivers commit to a pre-approved and designated route, and an approved speed limit.

The impact significance of increased road traffic accidents involving vehicles is assessed as high.

Impact TT02 – High Significance

13.5.1.3 Exceedance of transportation design capacity

For the purposes of the assessment, it has been assumed that wind turbine components will be transported by sea and enter the Kingdom of Saudi Arabia via Jubail Port in the Eastern Province. From this point of entry, the components will be loaded onto specialist transportation vehicles and transported to the development site.

At this stage of the design, there has been no investigation into the capacity and infrastructure of these ports or the road infrastructure from these points of entry into the Kingdom of Saudi Arabia to the development site. These are unusual loads and it is possible that infrastructure upgrades are required to safely import and transport the turbine components including junction improvements and widening, relocation of utilities, increasing the height of overhead transmission and telecommunication lines and structural reinforcement of culverts and underpasses. Furthermore, the minimum characteristics that roads must exhibit, as identified by DNV GL in the preliminary design, must be determined through detailed investigations.

The use of road infrastructure by oversized and heavy loads has the potential to damage road surfacing, leading to the development of potholes and other structural faults.

At this stage of the design there remains uncertainty around the scale and character of impacts arising from infrastructure upgrades. In accordance with the precautionary approach, this impact is assessed as high in the absence of mitigation.

Impact TT03 - High Significance

13.5.2 Operation Phase

There will be no permanent workforce located on site at the Park, and vehicle movements will be restricted to intermittent security and maintenance teams using small vehicles (e.g. pick-ups). During routine operations, there is no predicted impact on the existing traffic and transportation infrastructure. In the event of a major failure and the requirement to replace significant engineering components, there is likely to be a requirement to utilize cranes and heavy lifting equipment which will require transportation to site. This is not considered to be a routine operation and is further considered in Chapter 21 *Environmental Emergency Response Plan*.

13.5.3 Decommissioning Phase

Impacts during the decommissioning phase of the Park are anticipated to be similar to those experienced during the construction phase. See section 13.5.1 for details. For example, the dismantling and transportation of wind turbine components.

13.6 Mitigation and Recommendations

13.6.1 Construction Phase

Mitigation measures required during the construction phase of the Park, relate primarily to the development and implementation of traffic management plans (Table 13-5).

Table 13-5: Construction Phase Mitigation Measures

ID	Potential Significance	Mitigation Measures	Residual Significance
TT01	High		Moderate

ID	Potential Significance	Mitigation Measures	Residual Significance
TT02	High	The IPP must prepare a Logistics, Traffic and Transportation plan for the delivery of wind turbine components to the development site, this plan must be prepared in accordance with the recommendations shown in the IFC EHS Guidelines in order to ensure that full consideration is given to the potential impacts upon individuals and communities resulting from the increased risk of traffic accidents associated with the construction and decommissioning of the Park. This plan must ensure that road closures and diversions are kept to a minimum, and wherever practicable and safe to do so, peak transportation hours must be avoided to reduce impacts on commuters and other road users. The plan must also include a commitment for quarterly road safety driver training and annual defensive driving training for direct employees and the supply chain. The development of the plan must be undertaken in full consultation with stakeholders, including the emergency services, and the local community. This is to ensure full engagement of those likely to be impacted by road closures, diversions and police escorts; and to minimize the impacts of disruption. The plan should include active monitoring during the transportation of wind turbine components, and this should include surveys of the structural integrity of roads to identify potential damage and implement repairs.	Moderate
TT03	High	Prior to the preparation of the Logistics, Traffic and Transportation plan, a robust Logistics, Traffic and Transportation Study must first be completed. This plan must ascertain the requirements for infrastructure upgrades and other works necessary to allow the safe passage of oversized and heavy specialist transportation vehicles. The findings of this study should be analyzed and where possible, route selection should seek to avoid and minimize the requirements for infrastructure upgrades and other works (e.g. relocation of utilities, increasing the height of overhead transmission and telecommunication lines and structural reinforcement of culverts and underpasses).	Moderate

13.6.2 Operation Phase

It should be noted that no significant volumes of traffic will be generated during the operation phase of the Park. However, any vehicle and transportation requirements will be managed in accordance with the requirements of IFC EHS Guidelines 3.0: *Community Health and Safety* and IFC EHS Guidelines 4.0: *Construction and Decommissioning*.

13.6.3 Decommissioning Phase

The mitigation measures outlined in section 13.6.1 should be implemented during the decommissioning phase of the project.

13.7 Conclusion

This Traffic and Transport assessment has been based on a precautionary approach using data from desk-based review and current available design assumptions. As the design progresses and more details become available, the assessment should be reviewed with any updates and reported in an Addendum to this ESIA.

The impacts upon traffic and transportation, expected to arise as a result of the Park are principally associated with the transportation of wind turbine components and the use of specialist transportation vehicles. The IPP must undertake a Logistics, Traffic and Transportation Study based on which a robust Logistics, Traffic and Transportation Plan should be prepared. The plan should seek to minimize potential impact through informed route selection, training and ongoing monitoring.

The Logistics, Traffic and Transportation Study should consider the cumulative impact of the construction of the Dumat Al Jandal Wind Energy Park, alongside commencement of construction for the Sakaka Solar Energy Park, located to the south of Al Jouf International Airport. Although the impacts per project in isolation are not considered to be significant, in combination there is a risk of an adverse impact. Based on the information available at the time of preparing the ESIA, it has been assessed that Road 80 has capacity to accommodate the additional vehicles from both of these projects without detriment to the performance of this highway or the safety of its users.

13.8 References

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14. Socio-economic Aspects

14.1 Introduction

This chapter provides an overview of the existing Socio-Economic conditions present at the development site, and an evaluation and assessment of the potential impacts upon them which may arise as a result of the Dumat Al Jandal Wind Energy Park ('the Park').

National, regional and local socio-economic characteristics are described, including economy; population and demographics; employment; education; culture; municipal and social services; and land use and ownership. The assessment of impacts related to Socio-Economics has been carried out utilizing the standard methodology outlined in chapter 5 and assesses changes in the four following key socio-economic parameters:

- Effects of the project on socio-economic indicators;
- Effects on livelihoods and/or displacement of affected communities;
- Involvement of local manpower in project operation; and,
- Changes in land use and natural resources.

14.2 International and National Standards and Guidance

14.2.1 International standards

The international standards and guidance that are relevant for the Socio-Economic impact assessment of the Park are set out below.

14.2.1.1 World Bank/International Finance Corporation

The World Bank has a set of Safeguard Policies to reduce or eliminate the negative environmental and social impacts of projects. World Bank OP 4.01 requires that, for all Category A projects and, as appropriate, Category B projects, during the environmental assessment process the project sponsor should consult project-affected groups and local non-governmental organizations (NGOs) about the project's environmental aspects and take their views into account. Other World Bank Safeguard Policies that are relevant to this project include:

- OB/BP 4.12: Involuntary Resettlement.
- OP 4.10: Indigenous Peoples.
- OP 4.11: Physical Cultural Resources.

The International Finance Corporation (IFC) has a sustainability framework that consists of Performance Standards to manage environmental and social risks to projects. The following Performance Standards are relevant to this Socio-Economic impact assessment:

- Performance Standard 1: Assessment and Management of Social and Environmental Risks and Impacts.
- Performance Standard 5: Land Acquisition and Involuntary Resettlement.
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.
- Performance Standard 7: Indigenous Peoples.
- Performance Standard 8: Cultural Heritage.

In addition, IFC Performance standards recommend implementation of the IFC EHS guidelines. IFC Guidelines of relevance to this Socio-economic assessment include:

- IFC General EHS Guidelines (2007).

- IFC EHS Guidelines for Electric Power Transmission and Distribution (2007).
- IFC EHS Guidelines for Wind Energy (2015).

14.2.1.2 Equator Principles

The Equator Principles are a set of ten ethical lending principles which are aligned with the IFC Performance standards, and require the implementation of the IFC EHS guidelines as a minimum standard for all financed projects in non-designated countries. Key Equator Principles of relevance to this chapter include:

- Principle 4: Environmental and Social Management System and Equator Principles Action Plan.
- Principle 5: Stakeholder Engagement.
- Principle 6: Grievance Mechanism.

14.2.2 National legislation

13.8.1.1 National Labor Law

Royal Decree No. M/51, 27 September 2005 is the principal legislation defining the occupational health and safety rights of all workers within the Kingdom of Saudi Arabia. The law sets out provisions concerning workers' rights in terms of pay, welfare, working hours and conditions and access to healthcare. Part VIII of the law sets out provisions for the protection against occupational hazards, major industrial accidents and work injuries, as well as health and social services.

14.3 Baseline Environmental Conditions

The establishment of baseline Socio-Economic conditions has been undertaken using a combination of review of existing published information including government reports and statistics, academic studies, news reports, and any other available literature. Primary data from the community via stakeholder engagement activities will be undertaken at a later stage of the development in accordance with the stakeholder engagement plan, specifically interviews with local stakeholders and socio-economic questionnaires.

The General Authority for Statistics is the primary source for statistics for the Kingdom of Saudi Arabia. The Fifty First Statistical Year Book has been published for 2015 by the General Authority for Statistics and includes official statistical data on the activities and achievements of various public and private sector organizations in the Kingdom of Saudi Arabia.

14.3.1 Limitations

Primary data from the community via stakeholder and community engagement activities in accordance with the stakeholder engagement plan, specifically interviews with local stakeholders and Socio-Economic questionnaires was not available at the time of preparing this Socio Economic Chapter.

Information for the wider associated works required to support the development (e.g. logistical routes etc.) and the communities and stakeholders potentially affected by these was also not available at the time of drafting.

Inclusion of this information at a later stage of the development shall be undertaken as part of an addendum to this ESIA, and shall be completed prior to any construction works commencing by the IPP.

14.3.2 National Social Background

14.3.2.1 The Economy of the Kingdom of Saudi Arabia

The economy of the Kingdom of Saudi Arabia was agriculture-based with a largely nomadic population until oil was discovered in the 1930s, and it was not until the oil crisis of the 1970s that the country's economy began to grow rapidly. The Kingdom of Saudi Arabia possesses approximately one-fifth of the world's proven petroleum reserves and is the world's largest exporter of oil. The Kingdom of Saudi Arabia plays a leading role in the

Organization of the Petroleum Exporting Countries (OPEC), and has the highest Gross Domestic Product (GDP) in the Gulf Co-operation Council (GCC) region.

Historically, the economy has been tightly controlled and focused on exploitation of oil reserves, however, private sector growth, a policy to encourage employment of more Saudi nationals and increased diversification of the economy are a priority. Saudi Arabia acceded to the World Trade Organization (WTO) in 2005, to attract foreign investment and to help to diversify the economy. The diversification of the economy remains a priority for the Kingdom and is a central tenet of Vision 2030.

14.3.2.2 National Economic Activity

The petroleum sector is the main contributor to budget revenues, and in 2013 accounted for approximately 80 % of budget revenues, 45 % of GDP, and 90 % of export earnings (CIA, 2013). The Kingdom of Saudi Arabia's ambitious diversification program is aimed at expanding the existing manufacturing base into areas including logistics and transport, technology, medicine and finance. The Saudi government has made it a priority to diversify the industrial sector to reduce dependence on oil extraction and refinement (Ministry of Economy and Planning 2010).

The structural reform agenda is gaining momentum. The authorities have recently announced the launch of the National Transformation Plan which will support the achievement of the goals of Vision 2030. The plan aims to introduce structural measures such as improvements in public sector efficiency, privatization, further subsidy reforms and revenue diversification initiatives. As part of the National Transformation Plan, the Ministry of Energy, Industry and Mineral Resources (MEIM) is launching the National Renewable Energy Program (NREP). The NREP plans to implement 9.5 GW of renewable power by 2023.

The latest Middle East and North Africa (MENA) Economic Monitor Report, published in spring 2016 by the World Bank, reported that the Kingdom of Saudi Arabia's current account balance deteriorated with low oil prices, as hydrocarbons account for 89 % of exports. The current account balance moved from a surplus of 10 % of GDP in 2014 to a deficit of 5.2 % of GDP in 2016. The Economic Monitor Report (World Bank, 2016) expects Saudi's current account balance to improve but remain in deficit at 2.8 % of GDP in 2016.

Economic Monitor Report (World Bank, 2016) reports the fiscal deficit widened substantially in 2015 with moderate tightening in 2016. Expenditure cuts were limited to a modest 2.5 % in 2015 while the revenues dropped by 38 %. The fiscal deficit had a large increase to 18.9 % in 2015. The deficit was financed largely by Saudi Arabian Monetary Agency's (SAMA) large stock of foreign assets (estimated to exceed $600 billion by the end of 2015). The 2016 budget reflects a moderate tightening.

Measures have been taken within the Kingdom of Saudi Arabia to actively manage the budget deficit. Domestic oil prices were raised by 50 %, and natural gas and water prices are planned to be increased as well. In addition, budgetary allocations for education, health, and municipality services have faced significant cuts in an attempt to consolidate the deteriorating fiscal balances (World Bank, 2016). Some revenue generation measures have also been introduced, including 2.5 % tax on undeveloped land and $23 airport fee for international visitors. Other measures, including a 5 % Value Added Tax (VAT) and additional taxes on tobacco and soft drinks, have been announced awaiting implementation.

14.3.2.3 Population and Demographics

Up until the 1960s, most of the population was nomadic or semi-nomadic, but the recent rapid economic growth has resulted in more than 95 % of the population now being settled. In 2011, urbanization had reached 85 %. Some cities and oases now have densities of more than 1,000 people per square kilometer according to the 2004 and 2010 Census records.

The population statistics for the Kingdom of Saudi Arabia and the Al Jouf region, split between males and females and Saudi's and non-Saudi are listed in Table 14-1 (General Authority for Statistics, 2016). The data for Al Jouf region is split by gender, age-groups and nationality. The total population of the Kingdom of Saudi Arabia in mid-2015 was 31,015,999 (i.e. 20,774,906 Saudi and 10,241,093 non-Saudi) and the total population in Al Jouf Province was 497,509 (i.e. 373,662 Saudi and 123,847 non-Saudi). The proportion of Saudi nationals which comprise the population in Al Jouf Province is markedly higher than the national average, 75.12 % versus 66.98 % respectively. The younger age groups also comprise the majority of the population in Al Jouf.

Table 14-1: Population Statistics for Saudi Arabia and Al Jouf Region (source: General Authority for Statistics 2016)

Total			Non-Saudi			Saudi			Age Groups
National Population Statistics									
Total	Females	Males	Total	Females	Males	Total	Females	Males	Total
31015999	13363850	17652149	10241093	3160387	7080706	20774906	10203463	10571443	
Al Jouf Region Population Statistics									
56841	28607	28234	3293	1511	1782	53548	27096	26452	0-4
49180	24312	24868	3668	1710	1958	45512	22602	22910	5 - 9
40844	19930	20914	2916	1343	1573	37928	18587	19341	10 - 14
35805	17519	18286	2099	949	1150	33706	16570	17136	15 - 19
41364	18738	22626	4605	1289	3316	36759	17449	19310	20 - 24
48732	20385	28347	14190	3799	10391	34542	16586	17956	25 - 29
46195	18660	27535	17661	4672	12989	28534	13988	14546	30 - 34
47360	17729	29631	23831	6047	17784	23529	11682	11847	35 - 39
43409	15552	27857	22435	5151	17284	20974	10401	10573	40 - 44
29856	10535	19321	13653	2365	11288	16203	8170	8033	45 - 49
19689	6509	13180	7963	735	7228	11726	5774	5952	50 - 54
14472	5536	8936	4159	428	3731	10313	5108	5205	55 - 59
9653	4008	5645	1986	265	1721	7667	3743	3924	60 - 64
5935	3089	2846	717	82	635	5218	3007	2211	65 - 69
3645	1744	1901	485	281	204	3160	1463	1697	70 - 74
2273	933	1340	96	0	96	2177	933	1244	75 - 79
2256	836	1420	90	90	0	2166	746	1420	Above - 80
497509	**214622**	**282887**	**123847**	**30717**	**93130**	**373662**	**183905**	**189757**	**Total**

14.3.2.4 Labor Market

Employment statistics for the Kingdom of Saudi Arabia and the Al Jouf region, by main occupation groups have been compiled by the General Authority for Statistics for mid-2016. These statistics have also been generated for employed males and employed Saudi's (15 years and above). Although no explicit statistics have been provided for women, the number of women in employment can be deduced. Employment statistics are listed in Table 14-2 and Table 14-3.

provides the statistics for employed persons (15 years and above), and the total number of employed persons in Al Jouf administrative area is 178,970. Therefore 35.97 % of the total population in Al Jouf administrative area is in employment. This compares to 39.90 % for the Kingdom as a whole. The largest proportion of jobs in Al Jouf administrative area are within the service industry, followed by engineering and sales.

Of the 178,970 persons employed in the Al Jouf administrative area, 75,798 are Saudi nationals (approximately 43 %). This compares to 40.57 % for the national population, indicating that Saudi nationals comprise a slightly higher proportion of the employed persons in Al Jouf area.

64,528 of the 75,978 Saudi nationals employed are Saudi males, which by default indicates that 11,450 women are in employment in the Al Jouf area. Women comprise 15 % of the employed Saudi persons in the Al Jouf area. This compares to 16.64 % at the national level and so is marginally lower.

Table 14-3 lists the employed persons (15 years and above) by main economic activity groups and administrative area. Within the Al Jouf area, the principal employment sectors are public administration and defense (40,187), wholesale and retail (23,656), construction (23,579), and education (21,542).

Al Jouf region is famed within the Kingdom of Saudi Arabia for its olive groves and olive oil production. The region supports both small scale farms and the large mechanized plantation of Nadec. Al Jouf also holds an Olive Festival which gives producers a chance to market and promote their products. Al Jouf has the largest organic olive orchard in the world of approximately 600,000 trees and this was forecast to increase to nearly 1,000,000 trees.

The Saudi Industrial Property Authority (MODON) plans to develop an industrial city in the Al Jouf Province, for women. The proposed city is located on Road 80 to the west of the Saudi Electricity Company (SEC) power plant and sub-station, approximately 12 km south-east of the development site. This city will provide employment opportunities for Saudi women locally.

Table 14-2: Total Employed persons (15 Years and above) including total males, Saudis and Saudis males employed persons by Main Occupation Groups

Administrative Area	Lawmakers, Directors and business Managers	Specialists in Professional, Technical and Humanitarian Fields	Technicians in Professional, Technical and Humanitarian Fields	Occupations of Clerical	Occupations of Sales	Occupations of Services	Occupations of Agriculture, Animal Husbandry & Fishing	Occupations of Industrial, Chemical Operations and Food Industries	Occupations of Supporting Basic Engineering	Total
Total Employed persons (15 Years and above) by Main Occupation Groups										
AL - Jouf	3,352	13,041	20,938	14,377	21,088	59,596	7,164	2,157	37,257	178,970
KSA Total	**314,450**	**1,305,175**	**1,285,912**	**1,057,564**	**1,339,405**	**3,536,387**	**479,079**	**336,683**	**2,722,044**	**12,376,699**
Total Males Employed persons (15 Years and above) by Main Occupation Groups										
AL - Jouf	2,951	11,296	13,337	12,686	20,779	47,726	7,164	2,157	37,257	155,353
KSA Total	**290,837**	**1,100,064**	**861,717**	**865,732**	**1,300,824**	**2,957,085**	**476,259**	**321,548**	**2,720,349**	**10,894,415**
Saudis Employed persons (15 Years and above) by Main Occupation Groups										
AL - Jouf	3,082	7,332	16,407	13,368	5,696	26,918	1,765	0	1,230	75,798
KSA Total	**228,615**	**534,628**	**905,504**	**884,295**	**311,578**	**1,671,319**	**219,581**	**76,212**	**189,847**	**5,021,579**
Saudis Males Employed persons (15 Years and above) by Main Occupation Groups										
AL - Jouf	2,681	5,829	9,131	11,677	5,628	26,587	1,765	0	1,230	64,528
KSA Total	**206,898**	**374,560**	**528,397**	**701,615**	**279,258**	**1,619,708**	**216,761**	**68,809**	**189,847**	**4,185,853**

Table 14-3: Total Employed persons (15 Years and above) and Saudis Employed persons by Main Economic Activity Groups

	Total Employed persons (15 Years and above) by Main Economic Activity Groups		Saudis Employed persons (15 Years and above) by Main Economic Activity Groups	
	AL - Jouf	KSA Total	AL - Jouf	KSA Total
Agriculture, forestry and fishing	6,893	560,019	1,794	254,195
Mining and quarrying	213	171,479	57	135,138
Manufacturing	10,226	1,061,726	668	192,103
Electricity, gas, steam and air conditioning supply	830	82,238	830	54,939
Water supply; sewerage, waste management and remediation activities	232	49,261	99	26,029
Construction	23,579	2,012,045	1,007	129,459
Wholesale and retail trade; repair of motor vehicles and motorcycles	23,656	1,780,540	4,849	266,871
Transportation and storage	2,191	435,347	903	161,153
Accommodation and food service activities	8,029	382,345	103	34,952
Information and communication	716	134,993	716	50,499
Financial and insurance activities	998	143,274	998	88,764
Real estate activities	764	107,651	634	69,103

		AL - Jouf	KSA Total		AL - Jouf	KSA Total
Professional, scientific and technical activities		1,838	199,114		444	38,851
Administrative and support service activities		1,905	325,198		1,393	107,062
Public administration and defense; compulsory social security		40,187	1,873,789		33,487	1,818,057
Education		21,542	1,272,248		19,577	1,179,860
Human health and social work activities		9,695	552,803		7,073	346,215
Arts, entertainment and recreation		0	26,537		0	4,717
Other service activities		5,774	223,100		1,098	57,473
Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use		19,702	974,273		68	4,414
Activities of extraterritorial organizations and bodies		0	8,719		0	1,725
Total		**178,970**	**12,376,699**		**75,798**	**5,021,579**

14.3.2.5 Hajj Statistics

The Hajj statistics program aims at providing thorough and accurate data about the numbers of pilgrims according to their arrival ways and times. This would help in preparing plans and programs that are necessary to provide a distinct care for all pilgrims. The used unit in this process is the Muhrem (a pilgrim who is in ritual devotion). The counting process includes all Saudi and non-Saudi male and female individuals who arrive from the other Saudi cities to Makkah for the purpose of Hajj.

The 2016 Hajj statistics are listed in Table14-4.

Table14-4: 2016 Hajj Statistics

Domestic Pilgrims	Number	Females	Males
Saudis	170,492		
Non-Saudis	367,045		
Total	**537,537**		
Foreign Pilgrims	Number	Females	Males
Foreign Pilgrims	1,325,372	601,567	723,085
Total	**1,862,909**		

14.3.2.6 Education

General education in the Kingdom consists of kindergarten, six years of primary school and three years each of intermediate and high school. The Ministry of Education (MOE) sets overall standards for the country's educational system, and also oversees special education for the handicapped.

The first government school for girls was built in 1964; by the end of the 1990s there were girls' schools in every part of the Kingdom (MOE, 2015). Today, Saudi Arabia's education system includes 25 public and 27 private universities, with more planned; approximately 34,000 schools; and a large number of colleges and other institutions (MOE, 2015).

In addition to the dramatic growth of the educational system since the introduction of the First Development Plan in 1970, there has been an improvement in the quality of education; while the number of students in the educational system increased six-fold between the 1970s and the 1990s, the number of full-time teachers grew more than nine-fold. The Kingdom's ratio of 15 students to every teacher is one of the lowest in the world.

14.3.2.7 Governance

The Kingdom of Saudi Arabia is a monarchy based on Islam. The government is headed by the King, who is also the commander in chief of the military. The King appoints a Crown Prince who is second in line to the throne.

The King governs with the help of the Council of Ministers, also called the Cabinet, formed of 22 government ministries. The King is also advised by a legislative body called the Consultative Council (Majis Al-Shura). The Consultative Council proposed new laws and amends existing ones. It consists of 150 members who are appointed by the King for four-year terms that can be renewed. The country is divided into 13 provinces, with a governor and deputy governor in each, with its own council that advises the governor and deals with the development of the province.

14.3.2.8 Legal System

The judicial system and all legal matters in Saudi Arabia are based on Islamic law (Shari'ah) for both criminal and civil cases. Shari'ah presumes that a defendant is innocent until proven guilty, and only in serious crimes or in cases of repeat offenders is one likely to witness severe punishments. The Saudi court system consists of three main parts; the largest being the Shari'ah Courts, which hear most cases in the Saudi legal system. The Shari'ah courts are organized into several categories:

- Courts of the First Instance (Summary and General Courts);
- Courts of the Cassation; and,
- The Supreme Judicial Council.

King Salman bin Abdulaziz Al Saud sits at the top of the Saudi legal system and acts as the final court of appeal and as a source of pardon. Supplementing the Shari'ah courts is the Board of Grievances, which hears cases that involve the government. The third part of the Saudi court system consists of various committees within government ministries that address specific disputes, such as labor issues. In April 2005, a royal order approved in principle a plan to reorganize the judicial system, which was approved by a royal order in October 2007. Changes include the establishment of a Supreme Court and special commercial, labor and administrative courts.

14.3.2.9 Religion

The Kingdom of Saudi Arabia is an Islamic theocratic monarchy. Islam is the official religion of the Kingdom and it is required by law that all Saudi citizens be Muslims. The Government does not legally recognize or protect freedom of religion. The public practice of non-Muslim religions is prohibited, which is enforced by the Saudi Mutaween, or Committee for the Propagation of Virtue and the Prevention of Vice. According to a Pew Forum report (2009), approximately 97 % of the total population is Muslims, of these; 85-90 % are Sunni Muslim and 10-15 % are Shia Muslim.

14.3.2.10 Culture

The cultural heritage of Saudi Arabia is largely influenced by Islamic heritage, the role of the country as a trade center, and Bedouin traditions. The protection of cultural heritage has been entrusted to the Department of Culture at the Ministry of Culture and Information. Other institutions that promote culture include the King Fahd Library in Riyadh, which offers one of the largest collections of rare manuscripts on Arabic and Islamic literature; the National Museum in Riyadh, which is the largest museum in Saudi Arabia; and the Saudi Arabian Society for Culture and Arts. The Department of Museums and Antiques has responsibility for safeguarding the Kingdom's cultural heritage. Saudi Arabia places emphasis on preserving Islamic archaeological heritage. In addition to Makkah and Madinah, there are a large number of mosques within the Kingdom of Saudi Arabia, such as those built by the first caliphs after the death of the Prophet Muhammad, which have been subject to restoration. The restoration of the old Qasr Al-Hokm area in Riyadh and old Dariya, is an example of the Kingdom of Saudi Area's commitment to maintaining and preserving its cultural heritage for the benefit of its citizens. Similar restoration work of old quarters has been undertaken in other cities around the Kingdom of Saudi Arabia, such as Jeddah and Hail.

Traditional and cultural values are enforced by the Committee for the Promotion of Virtue and the Prevention of Vice. These values include the prohibition of alcoholic beverages and pork products, prohibition of driving by women, enforcement of conservative dress, with women wearing the abayah, segregation of unrelated males and females and closure of stores and shops during prayer times.

Bedouin constitute only a small portion of the total population of the Middle East although the area they inhabit is large due to their once nomadic lifestyle. The Bedouins were traditionally divided into tribes organized on several levels and governed by tribal chieftains, or Sheikhs, who were elected by tribal elders. The individual family unit (known as a tent or bayt), which typically consisted of three or four adults and any number of children, would adopt a seminomadic pastoral lifestyle, migrating throughout the year following water and plant resources. Royal Tribes traditionally herded camels, whilst others herded sheep, and goats. The fertile crescent of Arabia was in the past known for its lucrative trade of items such as exotic herbs and spices, gold, ivory and livestock, and the nomadic Bedouins were often mobile markets of this trade. Many Bedouin now adopt a modern lifestyle owing to Government appropriation of lands, reductions in their grazing ranges and increases in population, as well as the changes brought about by the discovery and development of oil fields in the region.

14.3.2.11 Local Education

The higher education facility in Al Jouf Province is Al Jouf University, which has 27,291 students and from which a total of 2824 students graduated in 2015. This University is located west of Sakaka, 21 km south west of the development site.

14.3.2.12 Healthcare

The Prince Mohammed Medical City is a 1000 bed medical facility in Al Jouf Province. This facility will be comprised of a fully equipped general hospital, cardiac center, eye hospital, general laboratory and rehabilitation center. This project is part of the Governments ongoing commitment to the balanced regional development of health care facilities in the Kingdom of Saudi Arabia, and to reduce pressure on specialized beds in the cities of Riyadh, Jeddah and Dammam.

The hospital is being constructed in two phases. Phase 1 which includes the main hospital is scheduled to be opened in April 2017. Phase 2 is scheduled to be completed in April 2019 and will include; a further 500 beds, the cardiology center, neuroscience center, oncology center, ophthalmology hospital and rehabilitation hospital.

When this project was formerly announced it was estimated to create 6,000 jobs locally for Saudi and non-Saudi staff.

14.3.2.13 Land Ownership

The Park is located within a Saudi Aramco reservation and therefore falls under the jurisdiction of the Ministry of Energy Industry and Mineral Resources. Under Saudi Aramco's General Instruction Manual Land Use Permit Procedures G.I. 2.716, there is a requirement to apply for a Land Use Permit (LUP) from Saudi Aramco Facilities Planning Department (FPD) to release the land for the Park. Following receipt of the LUP, FPD will conduct a preliminary review of the release request to ensure that the requested land is not needed for existing short-term or planned long-term land uses; and, this process involves internal and external consultation.

The Park has applied for, and has been awarded Land Use Permit (LUP) No. 43980.

14.3.2.14 Historic Land Use

There is no evidence of significant historical land-use or development within the development site. Existing informal land uses of nomadic herding and camping are likely to have taken place on the site previously, although with no formal authorization.

14.3.2.15 Existing Development (On Site)

A semi-permanent livestock farm was identified within the site, which is staffed by a single expatriate herder, sponsored by a Saudi national. This farm consists of a small pre-fabricated pen, an outhouse and a caravan for accommodation, and has been operational in this location for two years. At the time of writing the ESIA, this herder has demobilized and left the developable area. There is evidence on the site of previous similar land uses some of which appear more permanent, such as stone animal enclosures.

Several meteorological monitoring stations are present on the site; these are operated by Saudi Aramco.

Informal planting was found on site during site visits. The purpose of this planting in unclear but it is believed to be recreational. Each planted plot consists of a post and wire fence surrounding between one and five trees, grown in empty oil drums which have been filled with soil. There is evidence of recent maintenance at these locations in the form of hoses and water buckets.

As in many remote areas of Saudi Arabia, desert camping takes place within the site. Camping is a traditional recreational activity enjoyed by many Saudis and typically involves the erection of a tent, building of a fire and the drinking of coffee.

14.3.2.16 Existing Development (Adjacent to Site)

A railway line operated by Saudi Railway Authority, connecting the Hazm Al Jamid Phosphate Mine to the north with the processing plant at Ras Al-Khair to the east, runs north to south along the western boundary of the development site. This line transports 5 million tons of phosphate by train annually and each train consists of 150 wagons and 3 diesel locomotives.

A Gypsum quarry is located 1.5 km east of the development site boundary. Activities carried out at this facility include the extraction and storage of raw gypsum for sale and processing elsewhere. The site has been mined for less than fifteen years and is expected to continue operation for the near future.

14.3.2.17 Future Development

There will be plans to install overhead power lines from the Park to SEC infrastructure. The SEC is currently constructing a new 380 kV overhead powerline to the east of the Park, and it is likely that power generated by the Park will connect to this transmission line.

The licensed boundary of the gypsum quarry is unknown, and at this stage it is unknown whether plans exist to expand the existing quarry further towards the site boundary.

There are no other known plans for development within the boundary of the development site or in close proximity to its boundary.

14.3.3 Baseline Survey – Methodology

Existing published information has been used to establish the baseline Socio-Economic conditions. Primary data from the community via stakeholder engagement activities will be collected during subsequent phases of the development as identified in the Stakeholder Engagement Plan (SEP). The SEP identifies the range of people and organizations that may be regarded as stakeholders in the project and describes the strategy to be used for engaging with these stakeholders in a culturally appropriate manner. The results of the stakeholder and public consultation shall be incorporated into the addendum for the ESIA to be submitted for approval prior to construction.

14.4 Assessment Methodology

14.4.1 Approach

The approach to the Socio-economic assessment follows the methodology described in Chapter 5 of this ESIA.

14.4.2 Sensitive Receptors

Potential receptors relevant to the Socio-Economic impact assessment include:

- Farms, seasonal herders and recreational users within the site boundary and which utilize the wider landscape. The sensitivity of these receptors is valued as moderate on account their transient nature or limited likelihood of being occupied by vulnerable groups for extended periods;
- Local communities including settlements and businesses adjacent to the development site and along the route of potential transportation routes. The sensitivity of these receptors is valued as moderate on account of commercial premises and working age members of the community most likely to be affected and settlements on transport routes will not be receptors of impacts for extended periods;
- Local utility infrastructure and providers. The sensitivity of these receptors is valued as low on account of the ability to adapt and respond to change; and,
- Al-Jouf Airport (valued as moderate sensitivity on the basis that staff are not likely to comprise vulnerable groups).

14.5 Impact Assessment

The following section considers and assesses the potential impacts, both negative and positive, that the proposed Dumat Al Jandal Wind Energy Park may have upon the Socio-Economic factors identified by the baseline. Consideration has been given to impacts associated with the construction, operation and decommissioning phases of the Park. Each aspect has been assessed subjectively in accordance with the methodology outlined in chapter 5.

The Dumat Al Jandal Wind Energy Park is expected to be implemented in phases over a period of 5 years. Construction of Phase one was expected to start in Q2 2017, and will take approximately 20 months and will be in operation for 25 years.

14.5.1 Construction Phase

Specific potential impacts on the Socio-Economic environment due to construction activities are summarized in and discussed in the following text. Impacts associated with traffic, utility use, and health and safety of the local community, are addressed in the relevant sections of this ESIA; Section 13 - *Traffic and Transport Infrastructure*, Section 15 - *Utilities Infrastructure and Usage*, and Section 17 - *Health and Safety Aspects* respectively.

Table 14-5: Construction Phase Impacts Assessment

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
SE01	Local communities	Moderate	Economic growth during construction phase	Effect:	Positive	Low	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Provincial		
				Permanence:	Reversible		
SE02	Local communities	Moderate	Increased employment opportunities during construction	Effect:	Positive	Low	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Provincial		
				Permanence:	Reversible		
SE03	Local communities	Moderate	Education opportunities during construction phase	Effect:	Positive	Low	Low
				Action:	Indirect		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Long		
				Extent:	Provincial		
				Permanence:	Irreversible		
SE04		Low		Effect:	Negative	Low	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
	Local infrastructure		Increased pressure on municipal and social services due to increased population from construction workforce	Action:	Indirect		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Provincial		
				Permanence:	Reversible		
SE05	Livestock farm, recreational users	Moderate	Reduced access to land	Effect:	Negative	Moderate	Moderate
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Irreversible		
SE06	Livestock farm, recreational users	Moderate	Impact on existing livelihoods	Effect:	Negative	Moderate	Moderate
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Irreversible		

14.5.1.1 Economic growth during construction phase

The Park is expected to create 600 person years of construction work. In order to construct the first phase of the Park in the allocated 20 month timeframe, 180 workers will be required per phase. The majority of these workers are expected to be expatriates or migrants. It is therefore likely there will be a population increase within the local areas for a short period of time over the construction phase of the Park. While the workers will be housed within a specifically constructed accommodation camp, services will be required for the construction population, including provision of catering, and transportation, which may therefore provide economic opportunities for local and regional businesses, and directly benefit the community both in the income generated, and the residual spending impact to local vendors. However, given the self-contained nature of the construction camp, together with the recreational facilities provided therein, it is not anticipated that an increased demand for services across the whole commercial sector will be realized.

Construction materials will also be required, and while the Project is committed to sourcing materials locally where possible, for the purposes of this impact assessment, it is assumed that the materials required to construct the wind turbines will be manufactured and procured from a supplier based outside the Kingdom of Saudi Arabia. The level of economic growth during this period is therefore considered likely to be relatively low, though it has the opportunity to have direct benefits to the local community as outlined above, through provision of catering, transportation and other services required for the accommodation camp.

Impact SE01 – Low Significance

14.5.1.2 Increased employment opportunities during construction

The General Authority for Statistics revealed that of the 497,509 total population in the Al Jouf region, 123,847 were of non-Saudi origin. Phase one of the Park is expected to require approximately 180 people to construct within the required timeframe and it is anticipated that a significant proportion of these will be expatriates or migrants, slightly increasing the non-Saudi population. While Saudi Aramco promotes local hire, the nature of the employment during this phase may not see significant numbers of local residents employed. However, in relation to businesses supplying the construction camp, it may be expected that an increase in local employment opportunities will follow growth in these businesses.

Impact SE02 – Low Significance

14.5.1.3 Education opportunities during construction

The construction phase of the Park is unlikely to create impacts related to education; however, offering employment opportunities to the local and provincial population during the construction stage of the Park will help to promote local knowledge of the construction industry. This experience would enable creation of a local/provincial workforce capable of supporting the future construction of other projects within the National Renewable Energy Program as part of the Kingdom of Saudi Arabia’s Vision 2030 representing a positive impact to the community.

Impacts SE03 – Low Significance

14.5.1.4 Increased pressure on municipal and social services

The proposed population increase during the construction phase of the Park has the potential to place additional pressure on local municipal and social services, which have not been able to accommodate the rapid population growth of the area. However, the construction population will be temporary and is estimated to be only 180 persons per phase. The workforce will be housed in a self-contained camp which supplies all municipal services, including waste disposal, and wastewater treatment. Basic first aid facilities will also be made available on site. There may be intermittent demand for medical services in the event of an accident however, the negative impact on existing services is assessed as low.

Impact SE04 – Low Significance

14.5.1.5 Reduced access to land

Baseline studies have identified that there is no evidence of historical land-use within the development site itself. However, there is evidence of a semi-permanent farm, seasonal herders and settlements within and adjacent to the development site. It is also evident that the site is used for other recreational purposes, including informal recreational planting and desert camping. Whilst the users of this land are not indigenous peoples (Bedouin), many may be using the land for herding and recreational activities, and reduced access to the land for these activities may represent a negative impact. Areas around the development site will remain available for use. The stakeholder and public consultation process shall be undertaken during the next phases of the project design, and therefore the impact on the existing users of the land has taken a precautionary approach until results from the consultation are available. Impact on the existing users’ access to land is therefore considered to be of Moderate Significance.

Impact SE05 – Moderate Significance

14.5.1.6 Impact on existing livelihoods

Whilst baseline studies have indicated that there are no permanent properties located within the development site boundary, there are a variety of land uses within the area representing existing livelihoods. The semi-permanent livestock farm has left the site at the time of preparing this ESIA, although traditional recreational activities such as desert camping are present within the development site and permanent farming settlements are scattered to the north-east of the site.

It is unlikely that the construction of the Park will have a negative impact on the livelihoods of those receptors to the north-east and of the development. However, there is potential that the Park will have a negative impact on the recreational users as changes to the fabric of the site may displace these persons and activities. No other displacement of persons is expected as a result of the Park.

The stakeholder and public consultation process shall be undertaken during the next phases of the Park design, and therefore the impact on the existing users of the land has taken a precautionary approach until results from the consultation are available. Impact on the existing users loss of livelihood is therefore considered to be of Moderate Significance.

Impact SE06 – Moderate Significance

14.5.2 Operation Phase

The Park will be implemented in Phases over a period of 5 years, and will be in operation for 25 years. The operation of the Park requires employment for 80 operations and maintenance jobs.

Specific impacts on the Socio-Economic environment due to operational activities are summarized in Table 14-6 and discussed in the following text.

Table 14-6: Operation Phase Impacts Assessment

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
SE07	Local communities	Moderate	Employment opportunities during operation	Effect:	Positive	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Provincial		
				Permanence:	Reversible		
SE08	Al Jouf Airport	Moderate	Impact on radar used by Al Jouf Airport	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Rare		
				Duration:	Medium		
				Extent:	Provincial		
				Permanence:	Reversible		
SE09	Livestock farm / recreational users	Moderate	Impact on existing livelihoods / change to land use	Effect:	Negative	Moderate	Moderate
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Medium		
				Extent:	Local		
				Permanence:	Reversible		

14.5.2.1 Employment opportunities during operation

The operational activities of the Park require the creation of 80 operations and maintenance jobs. There will be no permanent site-based workforce during the operational phase. The operational staff will be distributed throughout existing offices which are remote to the project site. Maintenance and security staff will visit the site periodically but there will be no permanent site presence. It is therefore expected that the Park will have a low impact on the employment opportunities to the local labor market.

Impact SE07 – Low Significance

14.5.2.2 Impact on radar used by Al Jouf Airport

Al Jouf International Airport is located approximately 25km south east of the development site. The airport utilizes a single runway designated 10/28, with an asphalt surface measuring 3,661 by 45 meters. A radar has been identified at the airport location and it is assumed that this is used to track incoming and outgoing aircraft although the height of the antenna is presently unknown.

An obstacle evaluation was requested and undertaken by GACA. GACA has confirmed that they have no objection to the proposed development provided a 25km safeguarding distance is maintained to Al Jouf Airport.

Using the EUROCONTROL guideline, and based on its distance to the airport, Dumat al Jandal will fall within the Zone 3 or 4, should the radar at Al Jouf International Airport be a Primary Surveillance Radar (PSR). This will mean that a simple assessment would be required, should it be established that the proposed Park is within maximum instrumented range and in radar line of sight.

The Dumat al Jandal wind energy Park falls outside of the 6km safeguarding zone requested by the Ministry of Defence. On this basis, no significant impacts are predicted. However, it is recommended that further consultations are held with the Ministry of Defence and further analysis is undertaken to determine that the Park will not adversely impact on the radar systems of the military base.

Although further study is required in some situations, based on the conclusions of the radar assessment, there are likely to be minimal to no negative impact to the operation of this radar, and there are no associated socio-economic impacts.

Impact SE08 –Low Significance

14.5.2.3 Impact on existing livelihoods / reduced access to land

Once operational, the area where the Park is located will not be fenced. Whilst this will reduce access to small areas of land, it will not pose a barrier to the free movement of people or animals. However, without stakeholder engagement information it is currently unknown whether the existing livelihoods that have been recorded on site, including seasonal herders and recreational activities such as desert camping will continue to use the area. It is therefore anticipated the Park will result in a negative impact.

The stakeholder and public consultation process shall be undertaken during the next phases of the Park design, and therefore the impact on the existing users of the land and associated loss of livelihood has taken a precautionary approach until results from the consultation are available. Impact on the existing users is therefore considered to be of Moderate Significance.

Impact SE09 – Moderate Significance

14.5.3 Decommissioning Phase

The decommissioning of the Park following 20 years of operation is likely to involve the removal of the wind turbines and reinstatement of the site.

The specific impacts on the Socio-Economic environment due to these decommissioning activities are summarized in Table 14-7 and discussed in the following text:

Table 14-7: Decommissioning Phase Impacts Assessment

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
SE10	Al Jouf Power Plant	Low	Pressure on Al Jouf Power Plant during demolition due to reduction in energy production from wind power plant	Effect:	Negative	Moderate	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Provincial		
				Permanence:	Reversible		
SE11	Operational workforce	Moderate	Loss of employment opportunities	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible		
SE12	Livestock farming / recreational users	Moderate	Change of land use – opening up land so that it is available for use	Effect:	Positive	Low	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible		

14.5.3.1 Pressure on local utilities and services during demolition

During decommissioning of the Park, the Al Jouf power plant will be required to accommodate the increased demand for energy following the removal of local wind energy production. This is likely to result in a negative impact on the local utilities and services to compensate for the decommissioning of a 400 MW wind power plant. However, it is understood that the Saudi Electricity Company is also planning on developing a 50 MW solar PV power plant in this area. While the specifications of this power plant are currently unknown, it is likely to reduce the pressure on existing utilities and services.

Impact SE10 – Low Significance

14.5.3.2 Loss of employment opportunities

During decommissioning there will be a loss of employment opportunities. However, the scale of potential redundancies to the local labor market is assessed to be low on the basis that the site will be operated by an expatriate workforce that is remote to the development site.

Impact SE11 – Low Significance

14.5.3.3 Change of land use

The decommissioning of the Park and restoration of the development site will open up access to the site which was previously considered unusable. This would represent a positive impact to the local recreational users of the site and the farming settlements that utilize the wider landscape.

Impact SE12 – Low Significance

14.6 Mitigation

Implementation of mitigation measures will be required during construction, operation and decommissioning of the Park to minimize potential negative impacts of the activities. The mitigation measures comprise primarily of management procedures and are described in the subsequent sections. The following text assesses the impacts predicted as being of moderate to high significance against appropriate mitigation measures and establishes the residual impact significance.

In accordance with the methodology outlined by Chapter 5 – *Impact Assessment Methodology*, where appropriate, consideration has been given to the Equator Principles and IFC Performance Standards, which are applicable to Socio-Economic factors, during the development of proposed mitigation measures.

14.6.1 Construction Phase

Table 14-8 provides a summary of the potential Socio-Economic impacts associated with the Dumat Al Jandal Wind Energy Park, the mitigation proposed to lower the residual impacts and the significance following mitigation to confirm this.

Table 14-8: Construction Socio-Economic Impact and Mitigation Summary

ID	Impact	Potential Significance	Mitigation Measures	Residual Significance
SE05	Reduced access to land	Moderate	Contractor will minimize the area of land required for use during construction where possible. IPP will provide on-going community consultation and in particular provide guidance and assistance regarding use of alternative sites.	Low
SE06	Impacts on existing livelihoods	Moderate	Contractor will minimize the area of land required for use during construction where possible. IPP will provide on-going community consultation and in particular provide guidance and assistance regarding use of alternative sites. Where alternative sites cannot be identified and temporary loss of livelihood (or income) may result, compensation for the loss shall be identified and provided in accordance with IFC performance standard 5 and developed, documented and implemented through the use of a Livelihood Restoration Plan.	Low

14.6.1.1 Construction recommendations

The Contractor will be encouraged to make job opportunities during construction available to the local workforce, and promote engagement of the local population in the construction phase.

The IPP may consider the provision of training during the construction phase, to increase local knowledge of the construction industry and in particular at the Al Jouf University to advance training in skills required for construction and operation of renewable energy projects.

The Contractor will consider the extent to which infrastructure provided within the construction camp can provide ongoing benefit to the local population.

Livelihood restoration plans should be developed in advance of construction following consultation with relevant stakeholders and community users to ensure the Implementation of IFC Performance Standard 5. The plan should identify the level and type of compensation and should include non-monetary measures. The restoration plan should make special consideration of vulnerable groups and users, and ensure compensation is appropriate to their needs and is delivered in a manner which protects their right to any compensation.

14.6.2 Operation Phase

Table 14-9 below provides a summary of the Socio-Economic impacts associated with the operational phase of the Park, the mitigation proposed to lower the residual impacts and the significance following mitigation.

Table 14-9: Operation Socio-Economic Impact and Mitigation Summary

ID	Impact	Potential Significance	Mitigation Measures	Residual Significance
SE09	Impact on existing livelihoods / change to land use	Moderate	The impact of the development on local farmers and recreational users will be managed through the implementation of the Stakeholder Engagement Plan. The IPP will maintain links with this Affected Community, respond to concerns and provide guidance and assistance regarding use of alternative sites. Where alternative sites cannot be identified and temporary loss of livelihood (or income) may result, compensation for the loss shall be identified and provided in accordance with IFC performance standard 5 and developed, documented and implemented through the use of a Livelihood Restoration Plan. However, it is anticipated that seasonal holding pens and camps within the developable area can be relocated outside of the Park without any significant impact on livelihoods.	Low

14.6.2.1 Operation recommendations

The Park is not anticipated to result in any significant beneficial Socio-Economic impacts due to the intention for remote operation with no permanent workers based on site. Therefore, through the implementation of the following recommendations it is expected that the community will benefit from the operation of the Park.

The project proponent should establish a number of Key Performance Indicators (KPIs) to monitor the success of proposed mitigation and the creation of anticipated benefits by the Park.

The project proponent should establish social performance criteria for their suppliers, to promote the maximization of local sourcing of materials, local employment, and implementation of sound sustainable business practices. The IPP should establish its supply chain, and enter into a period of supply chain management and engagement to drive value to the community through its supply chain.

The project proponent should consider establishing a training program for local students. This proactive approach will demonstrate the project proponent's commitment to local employment and training.

The project proponent will continue stakeholder and public engagement in accordance with the Stakeholder Engagement Plan.

Livelihood restoration plans, if deemed necessary, should be developed in advance of construction following consultation with relevant stakeholders and community users to ensure the Implementation of IFC Performance Standard 5. The plan should identify the level and type of compensation and should include non-monetary measures. The restoration plan should make special consideration of vulnerable groups and users, and ensure compensation is appropriate to their needs and is delivered in a manner which protects their right to any compensation.

14.6.3 Decommissioning Phase

The impacts identified in the decommissioning phase have been assessed as being of low significance. As such no residual impacts are anticipated; however the following recommendations should be taken into consideration.

14.6.3.1 Decommissioning recommendations

While the change in land use resulting from the closure of the Park opening up the area to farmers and recreational use is considered of low significance, the project proponent should provide on-going community engagement to address any concerns the community may have following the closure of the Park.

While the loss of employment resulting from the closure of the Park is considered of low significance, they nonetheless represent a considerable change for the individuals affected. Therefore, the project proponent should implement a proactive succession planning program in advance of closure to identify alternative roles. This will provide security for employees and reduce the skills and experience loss from closure of the Park.

14.7 Conclusion

This Socio-Economic assessment has been based on a precautionary approach using data from desk-based review and current available design assumptions. As the design progresses and more details become available especially following stakeholder and public consultation, the Socio-Economic impact assessment will have to be re-visited with any updates reported in an Addendum to this ESIA.

A number of positive impacts during construction have been identified and recommendations have been identified to help accrue economic, employment and education opportunities. Mitigation measures have been suggested to reduce negative impacts on existing livelihoods and reduced access to land, including on-going community engagement and providing guidance and assistance regarding use of alternative sites.

A number of negative impacts during operation have been identified due to the remote workforce not directly benefiting the community and potential impacts to surrounding Affected Communities due to displacement. Mitigation has been identified with an emphasis on stakeholder engagement as per the Stakeholder Engagement Plan to reduce these impacts to a level where they are not significant.

15. Utilities Infrastructure & Usage

15.1 Introduction

This chapter outlines the existing utilities infrastructure and usage relevant to the Dumat al Jandal Wind Energy Park (the 'Park'), and describes the utility requirements for the Park, in order to identify and characterize impacts on the capacity of any existing utilities. The chapter describes services supply systems on a national, regional and local level based on utilities present in the area including: electricity provision, telecommunication services, water supply and wastewater management. The impact on waste facilities is discussed in Chapter 16 – *Waste Management;* the existing transport infrastructure is addressed in the Chapter 13 – *Traffic and Transport Infrastructure.*

The assessment of impacts related to utilities and infrastructure has been carried out utilizing the standard methodology outlined in chapter 5 - Impact Assessment Methodology.

15.2 International and National Standards and Guidance

15.2.1 IFC General EHS Guidelines

Section 1.3 *Wastewater and Ambient Water Quality* of the IFC EHS Guidelines (2007) applies to projects that have either direct or indirect discharge of process wastewater, wastewater, wastewater from utility operations or storm water to the environment; and includes measures for water conservation and reuse. The standard states that projects with the potential to generate process wastewater, sanitary (domestic) sewage, or storm water should incorporate the necessary precautions to avoid, minimize, and control adverse impacts to human health, safety or the environment.

The EHS Guidelines also cover occupational health and safety issues, including waste water treatment operations. Sanitary waste from the Park will be treated and disposed using a licensed waste water treatment facility.

Section 1.3 states that discharge of industrial wastewater, sanitary wastewater, wastewater from utility operations or storm water into public or private wastewater treatment systems should:

- Meet the pretreatment and monitoring requirements of the sewer treatment system into which it discharges;
- Not interfere, directly or indirectly, with the operation and maintenance of the collection and treatment systems, or pose a risk to worker health and safety, or adversely impact characteristics of residuals from wastewater treatment operations; and,
- Be discharged into municipal or centralized wastewater treatment systems that have adequate capacity to meet local regulatory requirements for treatment of wastewater generated from the project. Pretreatment of wastewater to meet regulatory requirements before discharge from the project site is required if the municipal or centralized wastewater treatment system receiving wastewater from the project does not have adequate capacity to maintain regulatory compliance.

15.2.2 IFC Performance Standard 3

Performance Standard 3 recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. Resource efficiency is the central tenet of this standard, and implementing technical and financially feasible and cost effective measures for improving efficiency in consumption of energy, water as well as other resources and material inputs (IFC, 2012).

The objectives for this Performance Standard are as follows:

- To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities;

- To promote more sustainable use of resources, including energy and water; and,
- To reduce project-related Greenhouse Gas (GHG) emissions.

As stated in IFC Performance Standard 3, *"when the project is a potentially significant consumer of water, in addition to applying the resource efficiency requirements of this Performance Standard, the client shall adopt measures that avoid or reduce water usage so that the project's water consumption does not have significant adverse impacts on others. These measures include, but are not limited to, the use of additional technically feasible water conservation measures within the client's operations, the use of alternative water supplies, water consumption offsets to reduce total demand for water resources to within the available supply, and evaluation of alternative project locations".*

15.2.3 IFC Performance Standard 4

Performance Standard 4 recognizes that project activities, equipment, and infrastructure often bring benefits to communities including employment, services, and opportunities for economic development. However, projects can also increase the potential for community exposure to risks and impacts arising from equipment accidents, structural failures, and releases of hazardous materials. Communities may also be affected by impacts on their natural resources, exposure to diseases, and the use of security personnel. While acknowledging the public authorities' role in promoting the health, safety and security of the public, this Performance Standard addresses the client's responsibility to avoid or minimize the risks and impacts to community health, safety and security that may arise from project activities. The level of risks and impacts described in this Performance Standard may be greater in projects located in conflict and post-conflict areas. (IFC, 2012)

The objectives of this Performance Standard are as follows:

- To avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances; and,
- To ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security.

As stated in IFC Performance Standard 4, *"The client will also avoid or minimize adverse impacts due to project activities on soil, water, and other natural resources in use by the affected communities"*

15.2.4 IFC Performance Standard 6

Performance Standard 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The requirements set out in this Performance Standard have been guided by the Convention on Biological Diversity, which defines biodiversity as *"the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems."*

The objectives of this Performance Standard are as follows:

- To protect and conserve biodiversity;
- To maintain the benefits from ecosystem services; and,
- To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

As stated in IFC Performance Standard 6: *"The risks and impacts identification process as set out in Performance Standard 1 should consider direct and indirect project-related impacts on biodiversity and ecosystem services and identify any significant residual impacts. This process will consider relevant threats to biodiversity and ecosystem services, especially focusing on habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution. It will also take into account the differing values attached to biodiversity and ecosystem services by Affected Communities and, where appropriate, other* *stakeholders. Where paragraphs 13–19 are applicable, the client should consider project-related impacts across the potentially affected landscape or seascape."*

15.2.5 IFC EHS Guidelines for Water and Sanitation

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry specific examples of Good International Industry Practice (GIIP). The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs.

The EHS Guidelines for *Water and Sanitation* include information relevant to the operation and maintenance of:

- potable water treatment and distribution systems; and,
- collection of sewage in centralized systems (such as piped sewer collection networks) or decentralized systems (such as septic tanks subsequently serviced by pump trucks) and treatment of collected sewage at centralized facilities.

15.2.6 National Legislation

GAME has developed wastewater discharge standards for the Kingdom of Saudi Arabia, developed to control the quality of direct discharges from facilities and persons operating in the Kingdom. These standards are designed to contribute towards meeting the Kingdom's ambient water quality objectives. These standards utilize use-related criteria and specify limits on individual discharges designed to protect those uses.

The quality standards set out in Table 15-1 apply to discharges to a Central Treatment Works (CTW) or shared sewerage system. These standards shall not be exceeded without specific authorization from the operator of the CTW.

Table 15-1: GAME Standards for Disposal to Municipal Collection System

Parameter	Units	Municipal Collecting System
Coarse material	-	-
Temperature	Δ °C (from ambient)	45
pH	pH units	5-10
TDS	mg/l	3000*
Turbidity	NTU	-
TSS	mg/l	600
BOD5	mg/l	500
COD	mg/l	1000
Total Oil & Grease[1]	mg/l	100
TKN (organic N)	mg/l	120
TOC	mg/l	1000
Phosphorus (total)	mg/l	50
Phosphate $(PO_4)^{3-}$	mg/l	n/a
Ammonia (as NH3)	mg/l	40
Chloride (as Cl)	mg/l	-
Total inorganic nitrogen(as (NO2 and NO3)	mg/l	n/a

Parameter	Units	Municipal Collecting System
Sodium	mg/l	1000
Sulfate	mg/l	500
Sulfide	mg/l	10

15.3 Baseline Environmental Conditions

15.3.1 Power

Electricity for the Kingdom of Saudi Arabia is provided by the Saudi Electricity Company (SEC). SEC was formed as a result of the merger of all existing electricity providers in April 2000. According to the latest available data (2015), SEC has the capacity to generate a maximum of 69,154 mega-watt (MW) of power. In 2015 it actually generated 50,171 MW of power, with a peak demand of 62,260 MW. It manages 67,446 km of transmission lines and 537,301 km of distribution lines (www.se.com.sa).

15.3.1.1 Al Jouf Power Plant

The Al Jouf Power Plant is owned and operated by SEC. The plant has an installed capacity of 382 MW and an average thermal efficiency of 25.8 % the power plant is estimated to consume 1,555 MBOE (thousand barrels of oil equivalent) per annum. The Power Plant is located approximately 20 km south of the development site boundary, adjacent to Road 80 (Figure 15-1).

Figure 15-1: Al Jouf Power Plant

15.3.1.2 Al Jouf Bulk Plant

Al Jouf Bulk Plant is owned and operated by Saudi Aramco, and is located approximately 28 km south-east of the development site boundary, along Road 80. This bulk plant is used for the storage and distribution of gasoline and supplies the Al Jouf Power Plant. Figure 15-2 shows Al Jouf Bulk Plant and Figure 15-6 shows the location.

Figure 15-2: Al Jouf Bulk Plant

15.3.1.3 Power Transmission Infrastructure

SEC is currently installing a new 380 kV overhead power line, to the east of the Park which connects to the Al Jouf Power Plant. It is intended for the Park to supply power into this overhead transmission line, via a new sub-station which will also be constructed by SEC.

Figure 15-3 shows the power transmission lines being constructed in the distance to the eastern boundary of the Park and Figure 15-6 shows the location.

Figure 15-3: Power Transmission Lines

15.3.2 Telecommunication

Telecommunications in the Kingdom of Saudi Arabia are provided by Saudi Telecommunications Company. Fixed telephone lines stood at 3.7 million at the end of 2015. Mobile communications within the Kingdom of Saudi Arabia are provided by four main suppliers;

- Bravo;
- Mobily;
- STC; and,
- Zain.

Mobile carriers are regulated by the Communication and Information Technology Commission. The total number of mobile subscriptions grew to around 53.1 million at the end of 2012, with a penetration rate of 186 %. Prepaid subscriptions constitute the majority (over 87 %) of all mobile subscriptions (CITC 2012). No underground cables are known to be present at the development site, either over or under the ground, and there are two mobile communication masts in proximity to the development site, one owned by Mobily, and one owned by Zain these are shown on Figure 15-6 and are located approximately 5 km south west of the development site boundary. Mobile coverage across the development site is intermittent.

The Communications and Information Technology Commission (CITC) has also shared details of its communications infrastructure in proximity to the Park (Figure 15.4). The data provided indicates that there are a series of mobile communication base stations to the south of the Park, and fiber optic cables which run parallel to Highway 80. The CITC has confirmed that they have no tele-communication facilities related to service providers within or immediately adjacent to the Park.

A further two communication masts have been identified to the immediate west of the Park, and adjacent to the railway corridor (Figure 15.5). These masts are not owned by the CITC. These masts are located at:

- 28.154531 N, 34.761295 E; and,
- 28.091986 N, 34.761295 E.

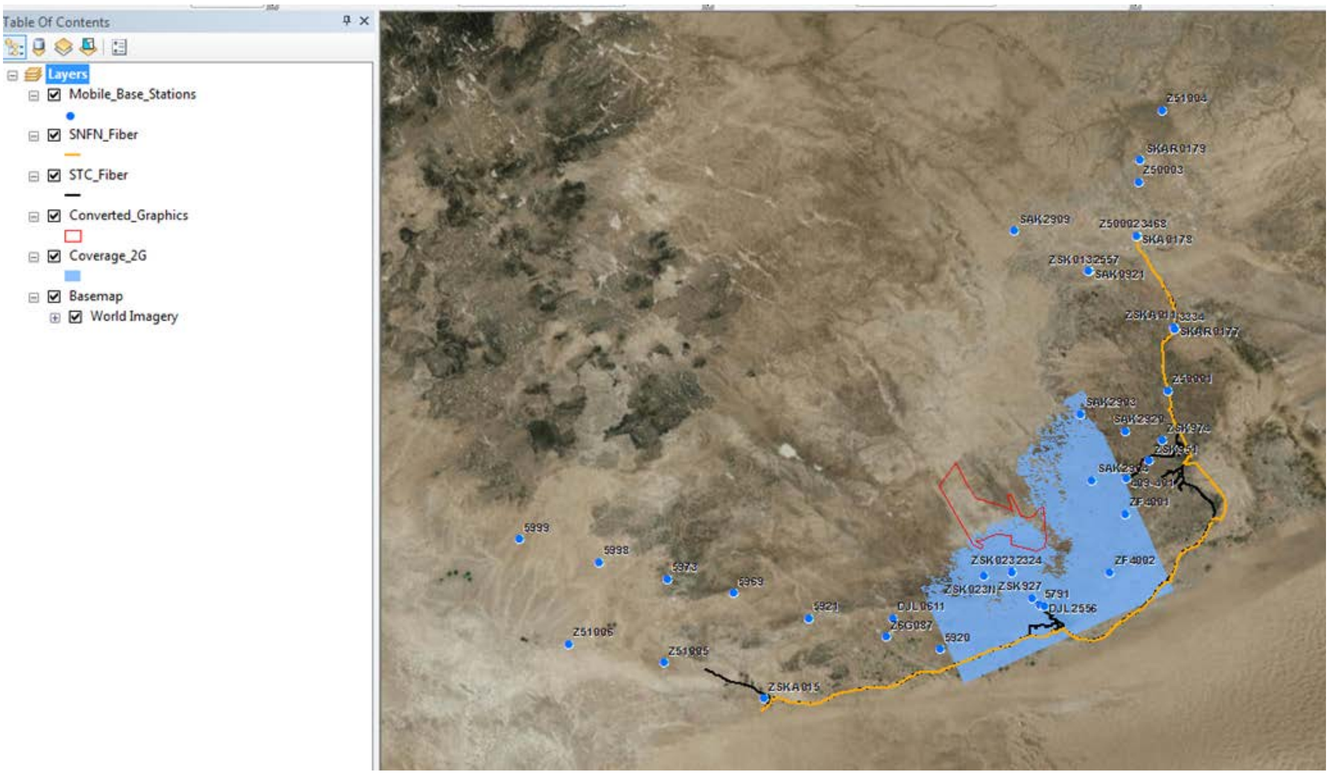

Figure 15.4 : Location of Communications Infrastructure and Coverage (Source: CITC)

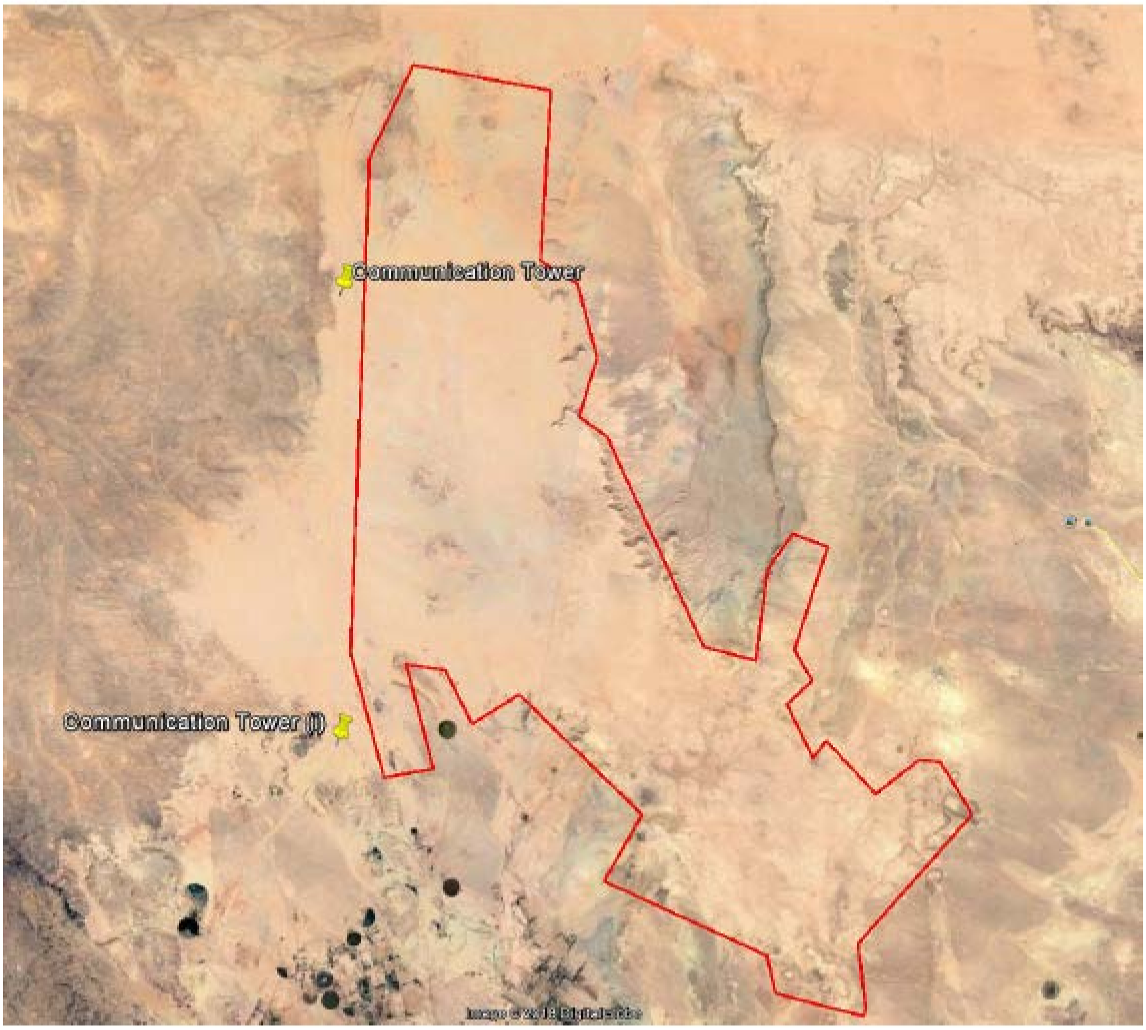

Figure 15.5 : Communication Masts to west of Dumat al Jandal Wind Energy Park

15.3.3 Water Supply and Wastewater

The National Water Company (NWC) manages water supply and wastewater treatment within the Kingdom of Saudi Arabia. The NWC is central to the Kingdom's ambitious plans set forth for development in all sectors and the achievement of water security and welfare of all citizens (www.bayt.com).

National Water Company (NWC) was established to provide water and wastewater services in accordance with the latest international standards NWC focuses on providing drinking water of high quality for all customers, providing all households with water and wastewater connections, the preservation of natural water resources, the protection of the environment, making maximum use of the Treated Sewage Effluent (TSE), and the development and training of qualified Saudi employees in accordance with the latest international standards (www.bayt.com).

The NWC has recently installed a municipal water supply line adjacent to Road 80, located to the south of the Park.

The Saline Water Conversion Company (SWCC) owns and operates a number of desalination plants in the Kingdom of Saudi Arabia. There are no SWCC plants in close proximity to the Park.

There are currently two existing waste water treatment plants in Al Jouf Province, with a combined capacity of 38,000 m^3/day. Two plants are currently under construction, with a further capacity of 57,500 m^3/day, and one additional plant is planned for construction in the future, with a capacity of 22,000 m^3/day (Tandfonline, 2015).

15.3.4 Radar

The development of the Park has the potential to interfere with radar and other forms of communication. A single radar has been identified at Al Jouf International Airport. It is assumed that this radar is utilized to track incoming and outgoing aircraft. The height of the antenna is presently unknown. A Ministry of Defense asset has also been identified in the local area, although no data related to this asset has been received at the time of writing.

15.3.5 Radar Impact Assessment

A radar impact assessment has been carried out in order to determine the potential effects of the Park upon this asset. In addition, an obstacle evaluation was requested and undertaken by GACA. GACA has confirmed that they have no objection to the proposed development provided a 25km safeguarding distance is maintained to Al Jouf Airport. As such, there is likely to be minimal to no negative impact to the operation of this radar.

The radar impact assessment has also considered the two communication masts to the west of the Park. Best practice guidelines from the Radio Advisory Board of Canada (RABC) recommend 1 km consultation zones around radio and television broadcasting antennas. These masts are in excess of 1km from the nearest turbines, and no impact is predicted when applying the 1km safeguarding zone. Using the EUROCONTROL guideline, and based on its distance to the airport, the Dumat al Jandal Wind Energy Park will fall within the Zone 3 or 4, should the radar at Al Jouf International Airport be a Primary Surveillance Radar (PSR). This will mean that a simple assessment would be required, should it be established that the proposed Park is within maximum instrumented range and in radar line of sight.

However it is recommended that further analysis is completed to determine the Fresnel Zones of the associated microwave paths and ensure the location of individual turbines does not compromise telecommunication signals (point-to-point). Receptor Identification

The existing utilities and infrastructure within and adjacent to the development site are listed in Table 15-2 and Figure 15-6 and are described further in the following section.

Table 15-2: Utilities and Infrastructure Receptors

Aspect	Northing	Easting
Saudi Aramco Bulk Plant	29°49'49.10"N	40°10'32.66"E
Saudi Electricity Company (SEC) Power Plant	29°46'32.11"N	40° 0'42.68"E
Saudi Electricity Company (SEC) Sub Station	29°46'48.21"N	40° 0'1.31"E
SEC Transmission Lines	See Figure 15-6	

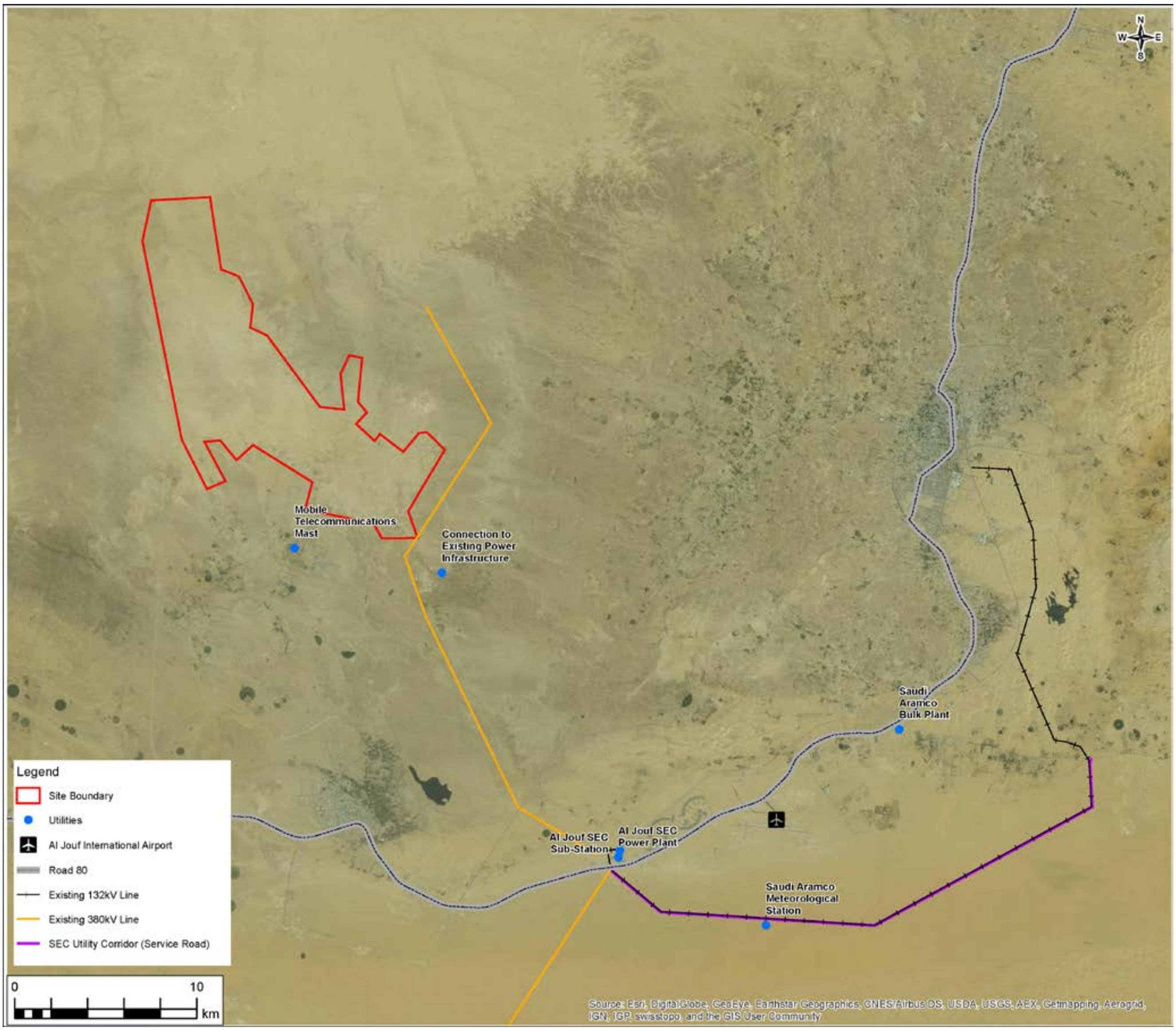

Figure 15-6: Utilities and Infrastructure Receptors

15.4 Assessment Methodology

The assessment of impacts was carried out according to the standard methodology described in Chapter 5 *Impact Assessment Methodology*.

Note that the assessment below is of the impact on existing utilities infrastructure where it exists only; potential impacts on aspects such as air quality, noise or on the proposed transport infrastructure are addressed in the relevant sections of this ESIA.

Consultation with the utility providers is ongoing, but it has been assumed that there will be no requirement for infrastructure upgrades during the construction and operation of the park, other than the construction by SEC of the sub-station to the east of the Park and the installation of new overhead transmission infrastructure. SEC has been fully engaged with the development of the Park and a Memorandum of Understanding (MOU) has been signed. The MOU commits SEC to providing the infrastructure to feed the power generated by the Park into the national power distribution network. During the construction phase of the development, the additional demand for water supplies and wastewater generation will be temporary. During the operation of the Park, there will only be a requirement for back-up auxiliary power for the two substations within the Park.

All development associated with the Park (i.e. that infrastructure which, were it not for the development of the Park would otherwise not be constructed), must be considered, (i.e. the SEC substation), as per the requirements of IFC Performance Standard 1, Paragraph 8.

The SEC substation will be constructed in line with the requirements of the EHS guidelines for electrical distribution. This requirement does not, however, extend to the existing power transmission lines, which are classified as existing development. The location and specifications for the SEC substation are yet to be confirmed. An assessment of impacts pertaining to this associated development will be carried out by the IPP during the next stage of development.

15.5 Impact Assessment

15.5.1 Construction Phase

Potential impacts upon utilities and utility infrastructure expected to arise during the construction phase of the Park are summarized in Table 15-3.

The assessment of impact is based on the following assumptions for the construction phase:

15.5.1.1 Power

Power at the construction camp will be provided by two 500 kw generators running for 720 hours per month each. Based on an average consumption of 33 gallons of diesel fuel per 24 hour day, this equates to an average monthly running utilization of 1,000 gallons per generator per month. These figures are based on conservative estimates of fuel utilization and do not account for summer cooling of buildings and other uses which may place additional demand upon the generators.

15.5.1.2 Telecommunications

A temporary connection will be made to the existing telecommunications network for the duration of the Park, from construction, to decommissioning. Due to the anticipated infrequent use of this system, it is not anticipated that any impacts upon the existing network will arise as a result of the introduction of the Park.

15.5.1.3 Potable Water

Bottled drinking water will be supplied to the site by tanker. It is estimated that 5.4 m^3 of bottled water will be delivered per day.

15.5.1.4 Non Potable Water

The estimated requirement of the construction workforce is based on an average per person per day water usage of 0.325 m^3. The construction workforce is expected to comprise of approximately 360 persons, 180 for each phase, and therefore, the daily water requirement for the construction camp is expected to be approximately 60 m^3.

A dry mix batching plant will be located on site, and water will be brought to the project site by tanker for concrete production. It is estimated that approximately 21,252 m^3 of water will be required (i.e. approximately 484 vehicle movements).

All non-potable water will be supplied by tanker from local supplies. Water supplied will be in compliance with the requirements of SAES-A-104 - *Wastewater Treatment, Reuse and Disposal*.

All water storage and discharge systems to be used during the construction phase of the Park including washout of concrete mixing areas, disposal of wastewater and on site storage will be designed during the next phase of the development and will be in compliance with IFC EHS Guidelines: Environmental 1.3 *Wastewater and Ambient Water Quality*.

15.5.1.5 Wastewater Collection and Treatment

Wastewater will be stored on site and collected by tankers for disposal at local wastewater treatment plants. It is anticipated that septic and wastewater tanks will be emptied daily during the construction phase.

Sanitary waste is expected to be generated at a rate of 0.325 m^3 per person per day as defined in Table 4 of the Saudi Aramco Engineering Standard SAES-A-104. It is anticipated that approximately 60 m^3 of sanitary waste will be generated on site each day.

Sanitary waste will be stored in underground tanks in designated storage areas and disposed of through a closed system. Detailed design of these storage areas and this system will be undertaken during the next phase of the development and will be compliant with IFC EHS Guidelines 1.3 *Wastewater and Ambient Water Quality*.

Table 15-3: Construction Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
UT1	Supply Infrastructure	Moderate	Disruption or overloading of the Supply Infrastructure	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Local Reversible	Low	Low

15.5.1.6 Disruption or overloading of the supply infrastructure

Stakeholder consultation and engagement with the Amana and local utility providers has not yet been approved by the Ministry of Energy, Industry and Mineral Resources (MEIM), and an understanding of utility supplies, networks and capacity remains undeveloped. In particular, relevant to the construction phase, the availability of water supplies and the capacity of existing wastewater treatment facilities.

However the maximum construction phase workforce is estimated to be 180 and this represents only 0.03 % of the population within Al Jouf Province and is not considered a significant increase on a temporary basis.

Until the completion of consultation with the Amana and local utility providers has been concluded, it has reasonably been assumed that capacity is available within the municipal supply infrastructure to accommodate the utility temporary requirements of the Park and the significance of this impact is assessed as low.

Impact UT1 – Low Significance

15.5.2 Operation Phase

During the operation phase of the project there will be no permanent workforce based at the Park. Only intermittent security and maintenance teams will visit the Park. On this basis, the demand for utilities and potential impacts on utility infrastructure are considered to be negligible.

Potential impacts upon utilities and utility infrastructure expected to arise during the operation phase are summarized in Table14-4.

The assessment of impact is based on the following assumptions for the operation phase:

15.5.2.1 Power

The SEC will provide auxiliary power to the two sub-stations within the Park. This has been agreed in a MOU and has been accounted for in the grid transmission studies undertaken by the SEC.

When fully implemented the Park is expected to generate approximately 1100 giga-watt hours (GWh) per annum, displacing 2,000 Thousand Barrels of Oil Equivalent (MBOE) of hydrocarbons per annum and 800 Thousand tons (Mt) of CO2 per annum.

15.5.2.2 Telecommunications

The Park will be fully integrated to the national SCADA system.

15.5.2.3 Potable Water

Limited drinking water supplies will be required during operation of the Park. Bottled water will be provided to the sub-stations to ensure that there are supplies for security and maintenance teams which intermittently visit the Park.

15.5.2.4 Non Potable Water

Limited water supplies will be required during operation of the Park. It is assumed that the sub-stations will provide welfare facilities for security and maintenance teams which intermittently visit the Park. This includes toilets. The sub-stations will be provided with a 500 gallon water tank for toilets and sinks, and water will be supplied via tanker.

15.5.2.5 Wastewater Collection and Treatment

Limited wastewater will be generated during operation of the Park. It is assumed that the sub-stations will provide welfare facilities for security and maintenance teams which intermittently visit the Park. This includes toilets. It is proposed to install a PVC septic tank with capacity for 5 persons associated with the sub-station buildings, although sanitary waste generation will be intermittent.

Table 15-4: Operation Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
UT2	Supply Infrastructure	Moderate	Disruption or overloading of the Supply Infrastructure	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Rare Short Local Reversible	Low	Low
UT3	Supply Infrastructure	Moderate	Reduction of demand on existing infrastructure	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Positive Direct Certain Continuous Medium National Reversible	Moderate	Moderate
UT4	Telecommunication Infrastructure	Moderate	Interference of telecommunication infrastructure	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Continuous Medium Provincial Reversible	Moderate	Moderate

15.5.2.6 Disruption or overloading of the supply infrastructure

There will be no permanent workforce based at the Park during the operation phase. Security and maintenance personnel are anticipated to intermittently utilize welfare facilities within the sub-station buildings during the operation phase of the Park. The additional demands on the utility infrastructure associated with this workforce are considered negligible, and impacts upon existing infrastructure are expected to be of low significance.

The SEC has completed grid connection studies for the connection of the Park to local infrastructure. No concerns have been raised by the SEC.

Impact UT2 – Low Significance

15.5.2.7 Reduction of Demand on Existing Infrastructure

The Dumat al Jandal Wind Energy Park will reduce the demand placed on SEC power generation infrastructure. It is estimated that the Park will generate approximately 1100 giga-watt hours (GWh) per annum, displacing 2,000 Thousand Barrels of Oil Equivalent (MBOE) of hydrocarbons per annum and 800 Thousand tons (Mt) of CO_2 per annum. This is assessed as a positive impact and is assessed as being of moderate significance.

Impact UT3 - Moderate Significance

15.5.2.8 Interference of Telecommunication Infrastructure

Two communication masts have been identified in proximity to the Dumat al Jandal Wind Energy Park. A setback distance of 1km has been applied to the two telecommunications towers. In reality wind turbine induced interference is difficult to predict as the level of interference depends on several factors related to the emitter, the receptor, the wind farm and the propagation environment including:

- Relative position of the emitter, receptor and wind turbines;
- Transmit Power (Strength of emitted signal);
- Noise sensitivity of the system;
- Bandwidth of the system;
- Information transfer rate;
- Size of the chosen turbine;
- Orientation of blades and rotor; and,
- Rotor rotational speed.

In areas where wind turbines could have a perceptible impact on a received signal, a number of mitigation measures may be available to reduce or eliminate the effect of wind turbines on such radio communication systems. During the planning stage, the placement of individual wind turbines should take into consideration local microwave. Moving a wind turbine, a short distance may be enough to clear the radio-communication path and eliminate the potential for interference.

Proper care is taken at the wind farm planning stage, radio-communication systems will most likely not be impacted. However at this stage of the design, a precautionary approach has been taken an impact of moderate significance is predicted.

Impact UT4 - Moderate Significance

15.5.3 Decommissioning Phase

During the decommissioning of the Park, impacts experienced are expected to be identical to those experienced during the construction of the Park. See Section 15.5.1 for details.

15.6 Mitigation & Recommendations

No significant adverse impacts during the construction and decommissioning of the Park are predicted, and no specific mitigation is proposed. It is however recommended that the utilization of utilities (e.g. water, power) is monitored during each phase of the project to develop an understanding of consumption rates and enable the implementation of continuous improvement measures to reduce consumption. The implementation of such measures will contribute towards the objectives of IFC Performance Standard 3 and resource efficiency.

A potential impact of moderate significance is predicted on the two communication masts located to the west of the Park. Proposed mitigation measures are described in

Table 15.5 : Operation Phase Mitigation

ID	Potential Significance	Mitigation Measures	Residual Significance
UT4	Moderate	In addition to undertaking further consultation with the owners of the masts, prevention and control measures to address impacts to telecommunications systems include the following: • Modify placement of wind turbines to avoid direct physical interference of point-to-point communication systems; • consultation with relevant operators can assist in establishing the location of telecommunication links and relevant buffers to be applied in order to minimize impacts; • Install a relay next to the wind farm; • Modify the existing aerial; and, • Install an amplifier to boost the signal • If degradation is noticed in the operational phase of the project, there are a number of mitigation methods available. These include: o replacing the receive antenna with one that has a better discrimination to the unwanted signals, o relocating either the transmitter or receiver, or o switching to an alternate means of receiving the information (fibre-optics or other means).	Low

15.7 Conclusion

This assessment of Utilities and Infrastructure has been based on a precautionary approach using data from desk-based review, stakeholder consultations and current available design assumptions. As the design progresses and more details become available, assessment will have to be re-visited with any updates reported in an Addendum to this ESIA.

No significant impacts upon existing utilities and infrastructure are expected to occur as a result of the construction, operation of decommissioning of the Dumat Al Jandal Wind Energy Park.

15.8 References

Drewes et al., (2015) *Water reuse in the Kingdom of Saudi Arabia* [Available Online] https://www.researchgate.net/publication/269599336_Water_reuse_in_the_Kingdom_of_Saudi_Arabia_-_status_prospects_and_research_needs

Tandfonline (2015), *Treated wastewater use in Saudi Arabia: challenges and initiatives* [Available Online] at: http://www.tandfonline.com/doi/full/10.1080/07900627.2015.1116435

www.bayt.com accessed on 29th May 2017

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16. Waste Management

16.1 Introduction

This chapter provides an overview of the waste management facilities available during the construction, operation and decommissioning of the Dumat Al Jandal Wind Energy Park (the Park), and an evaluation and assessment of the potential impacts upon them which may arise as a result of the development of the Park.

16.2 International and National Standards and Guidance

16.2.1 International Conventions

16.2.1.1 Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted internationally on 22 March 1989. The Kingdom of Saudi Arabia ratified the Convention in 1990.

The overarching objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as "hazardous wastes" based on their origin and/or composition and their characteristics, as well as two types of wastes defined as "other wastes" - household waste and incinerator ash (www.basel.int).

The provisions of the Convention center around the following principal aims:

- the reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal;
- the restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management; and
- a regulatory system applying to cases where transboundary movements are permissible (www.basel.int).

16.2.2 IFC EHS Guidelines

Sections 1.5 *Hazardous Materials Management* and 1.6 *Waste Management* of the IFC EHS Guidelines (2007), apply to projects which generate, store or handle any quantity of waste, including hazardous waste. The main objectives of the guidelines are the protection of the workforce and the prevention and control of releases and accidents.

The guidelines state that facilities that generate and store wastes should practice the following:

- Establishing waste management priorities at the outset of activities based on an understanding of potential Environmental, Health, and Safety (EHS) risks and impacts and considering waste generation and its consequences;
- Establishing a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes;
- Avoiding or minimizing the generation waste materials, as far as practicable;
- Where waste generation cannot be avoided but has been minimized, recovering and reusing waste; and,
- Where waste cannot be recovered or reused, treating, destroying, and disposing of it in an environmentally sound manner.

Section 1.6 *Waste Management* states that waste management should be addressed through a waste management system that addresses issues linked to waste minimization, generation, transport, disposal and monitoring.

The treatment and disposal of waste should only be undertaken by qualified commercial or government-owned waste vendors.

Section 3 *Community Health and Safety* of the IFC EHS Guidelines contains recommendations which complements the guidance provided in the preceding environmental and occupational health and safety sections, specifically addressing some aspects of project activities taking place outside of the traditional project boundaries, but nonetheless related to the project operations, as may be applicable on a project basis. These issues may arise at any stage of a project life cycle and can have an impact beyond the life of the project.

Section 3.5 *Transport of Hazardous Materials* identifies procedures which should be in place in order to ensure compliance with local laws and international requirements applicable to the transport of hazardous materials. These include:

- Proper labeling of containers, including the identity and quantity of the contents, hazards, and shipper contact information;
- Providing a shipping document (e.g. shipping manifest) that describes the contents of the load and its associated hazards in addition to the labeling of the containers. The shipping document should establish a chain-of-custody using multiple signed copies to show that the waste was properly shipped, transported and received by the recycling or treatment/disposal facility;
- Ensuring that the volume, nature, integrity and protection of packaging and containers used for transport are appropriate for the type and quantity of hazardous material and modes of transport involved;
- Ensuring adequate transport vehicle specifications;
- Training employees involved in the transportation of hazardous materials regarding proper shipping procedures and emergency procedures. Using labeling and placarding (external signs on transport vehicles), as required; and,
- Providing the necessary means for emergency response on call 24 hours/day

Section 4 of the IFC EHS Guidelines contains recommendations related to construction and decommissioning of projects, it contains additional, specific guidance on prevention and control of community health and safety impacts that may occur during new project development, at the end of the project life-cycle, or due to expansion or modification of existing project facilities.

Section 4.1 *Environment* contains recommendations related to the management of solid wastes during construction and decommissioning. This includes non-hazardous solid wastes such as excess fill materials from grading and excavation activities, scrap wood and metals, and small concrete spills office, kitchen, and dormitory wastes when these types of operations are part of construction project activities. The guidance also contains recommendations related to non-hazardous wastes including contaminated soils, which could potentially be encountered on-site due to previous land use activities, or small amounts of machinery maintenance materials, such as oily rags, used oil filters, and used oil, as well as spill cleanup materials from oil and fuel spills. This section also contains recommendations related to waste water.

16.2.3 Performance Standard 3 Resource Efficiency and Pollution Prevention

Performance Standard 3 recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. Resource efficiency is the central tenet of this standard, and implementing technical and financially feasible and cost effective measures for improving efficiency in consumption of energy, water as well as other resources and material inputs (IFC, 2012).

The standard provides guidelines for the management of wastes and hazardous material management. It states that the projects will avoid the generation of hazardous and non-hazardous waste materials. Where waste generation cannot be avoided, the client will reduce the generation of waste, and recover and reuse waste in a manner that is safe for human health and the environment. Where waste cannot be recovered or reused, the client will treat, destroy, or dispose of it in an environmentally sound manner that includes the appropriate control of emissions and residues resulting from the handling and processing of the waste material. If the generated waste is considered hazardous, the client will adopt GIIP alternatives for its environmentally sound disposal while adhering to the limitations applicable to its transboundary movement (IFC, 2012).

16.2.4 Performance Standard 4: Community Health, Safety and Security

Performance Standard 4 recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. In addition, communities that are already subjected to impacts from climate change may also experience an acceleration and/or intensification of impacts due to project activities. While acknowledging the public authorities' role in promoting the health, safety, and security of the public, this Performance Standard addresses the client's responsibility to avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable groups. In conflict and post-conflict areas, the level of risks and impacts described in this Performance Standard may be greater. The risks that a project could exacerbate an already sensitive local situation and stress scarce local resources should not be overlooked as it may lead to further conflict

The key objectives of this Performance Standard are:

- To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances.
- To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the Affected Communities.

Paragraph 7 *Hazardous Materials Management and Safety* of this Performance Standard relates to the transport and disposal of wastes and the impacts they may have upon a community through such actions as exposure to pesticides. The paragraph states that *"The client will exercise commercially reasonable efforts to control the safety of deliveries of hazardous materials, and of transportation and disposal of hazardous wastes, and will implement measures to avoid or control community exposure to pesticides, in accordance with the requirements of Performance Standard 3."*

16.2.5 National Legislation

The GAME has a series of Environmental Standards that cover the management of waste materials, specifically those relating to Waste Acceptance, Waste Classification, Waste Control, Waste Handling & Storage and Waste Transportation.

The *Waste Acceptance* Standard (Environmental Standard 8) requires waste producers to undertake an audit of their waste in order to establish the characteristics and appropriate disposal routes for the wastes. All hazardous wastes destined for landfill should be subjected to treatment to allow the waste to meet the waste acceptance criteria for hazardous waste landfills. In the case of non-hazardous wastes an evaluation of the treatment options should be made. However, the evaluation of treatment options is not required if the treatment would not reduce the quantity of the waste or any hazards that it may pose to human health or the environment. Operators of landfills are required to undertake compliance testing on waste materials to ensure that they comply with the Waste Acceptance Criteria for the landfill.

The *Waste Control* Standard (Environmental Standard 12) establishes a framework for the management and transport of wastes within the Kingdom of Saudi Arabia, which includes:

i. the assignment of a Duty of Care to Waste Handlers;

ii. tracking systems, which provide information to assist agencies and emergency services and ensure wastes are directed to appropriate facilities;

iii. prior notification systems for hazardous waste activities, which provide participating Enforcing Authorities with access to information to assess the appropriateness of proposed movements of hazardous wastes in terms of facility selection;

iv. systems for registering Waste Transporters and the regulation of Generators and TSD facilities so that tracking and notification functions are compatible throughout the Kingdom of Saudi Arabia; and,

v. a waste licensing regime for storage, treatment and disposal facilities so that a uniform method of waste control is adopted throughout the Kingdom of Saudi Arabia and site operators are accountable for their waste activities.

The *Waste Handling & Storage* Standard (Environmental Standard 13) outlines good practice for the storage and handling of wastes and is applicable to all waste handlers from waste generators and its onward transfer for recycling, treatment or disposal.

The *Waste Transportation* Standard (Environmental Standard 15) provides vehicle specifications required for safe transportation of waste and the requirements for labelling (including international standards and trans-frontier movements) though these labelling requirements do not supersede the waste classifications. Standard 13 considers transportation of wastes by road, rail and sea, but does not extend to radioactive wastes or explosives or the on-site transportation of wastes.

The Standard on the *Design and Operation of Landfills* (Environmental Standard 16) outlines the three classifications of landfill, three types of landfill; Class I, Class II and Class III for hazardous, non-hazardous and inert materials. It provides the design requirements that should be followed in the development and operation of a landfill facility.

16.3 Baseline Environmental Conditions

16.3.1 National Context

The Kingdom of Saudi Arabia has experienced rapid industrialization, urbanization, and high population growth all of which have cumulatively resulted in increased generation of waste. The Ninth Development Plan notes that population growth over the last 40 years has increased pressures on the environment, and goes on to identify that environmental pollutants generated by human activity, most notably solid and liquid waste, have increased in recent years (Ministry of Economy and Planning, 2009a).

The World Bank average waste generation per capita (kg/capita/day) for the Middle East is 1.1 kg/cap/day (World Bank, 2012). The World Bank predicts that in the Kingdom of Saudi Arabia, per capita waste generation will be 1.7 kilograms per day by 2025, resulting in a total of 50,424 tons per day of municipal solid waste (World Bank 2012).

Municipal solid waste in the Kingdom of Saudi Arabia is currently collected by the local municipality and taken to landfill sites. A number of waste management companies operate within the Kingdom of Saudi Arabia, collecting commercial and industrial wastes under contract.

Management of the increasing amount of solid waste is an ongoing problem in the Kingdom of Saudi Arabia. According to the General Administration of Meteorology and Environment (GAME), the proper management of waste is prevented by the following factors:

- Absence of institutional infrastructure capable of planning, regulating, and implementing an integrated waste management system;
- Lack of capacity for waste collection and transport;
- Operational problems, including inadequate maintenance capabilities;
- Lack of qualified and trained technical staff for management and operation, coupled with low pay;
- Shortfall in financing;
- Lack of public landfill spaces that adhere to environmental regulations;
- Lack of legal and regulatory systems to facilitate integrated waste management; and,
- Low-level public awareness regarding the issues surrounding solid waste.

Initiatives are underway in the Kingdom of Saudi Arabia to reduce greenhouse gas emissions in solid waste management. These include landfill gas collection, the development of flaring systems and transformation of waste materials to organic fuels. The strategic plans for major cities have adopted the concept of waste minimization. The strategic plan for Jeddah which was initiated in 2005 emphasized waste management programs, in order to reduce landfill requirements by waste reduction technologies including composting. The key projects included in this initiative are the Jeddah Oil Landfill, Jeddah New Landfill and the Jeddah Municipality recycling initiative (Third National Communication, 2016).

In 2012, more than 40 recycling companies were working at different levels and with different types of waste in the Kingdom of Saudi Arabia (Alameer, 2014). In 2012, Exitcom concluded a contract with International Computer Company (ICC) to build the first e-scrap recycling plant in Saudi Arabia. E-Scrap is comprised of electronic waste components such as computer parts and other circuitry. It is estimated that Saudi Arabia produces more than 3 million tonnes of e-scrap per annum. Company level initiatives have also been introduced in recent years, Saudi Aramco recycled approximately, 960 tons of paper and carton in 2013 (Saudi Aramco, 2013).

The GAME distinguishes three physical forms of waste; liquid waste, solid waste and sludge, and characterizes waste as hazardous, non-hazardous and inert. The following sections identify the wastes anticipated to be generated as a result of the Park.

16.3.1.1 Local Context

16.3.1.1.1 Waste Management Facilities within Al Jouf Province

There is a municipal waste landfill facility located approximately 65 km to the south-east of the Park. The site is owned by the Ministry of Municipal and Rural Affairs and operated by Saraya Al Jazera Contracting Company. The landfill serves Sakaka and the neighboring villages and is comprised of two areas. The first area is currently in operation and covers an area of 2,000,000 m^2 and only 2 % of capacity has been utilized. The second area covers an area of 750,000 m^2 and has 100 % capacity available (i.e. it has not yet been put into operation).

The facility receives municipal waste, construction waste, green waste (e.g. tree cuttings etc.) and liquid waste from abattoirs. Daily quantities received comprise approximately 450 tons of municipal waste, 180 tons of solid waste including construction waste and debris. No waste segregation or recycling is undertaken.

The landfill is not engineered and waste is placed within designated cells (100 m x 25 m) to a height of 1 m and then covered with 0.3 m of sand. This layer is then compacted using a bulldozer. Subsequent layers are filled on top of each other in the same manner until approximately 6-8 layers have been compacted.

Liquid waste from the abattoir is put into a 4 m deep pit with sodium hydroxide and then buried with sand to prevent odors.

Based on the data provided by the Ministry of Municipal and Rural Affairs there is capacity within this facility to receive construction waste from the project.

Global Environmental Management Services (GEMS) also operate a waste management plant within Jouf Province, although no details have been made available for this facility.

Ongoing stakeholder consultation is to be carried out during the next phases of the development. Through this, detailed locations and capacities of waste handling facilities in the vicinity of the development site will be confirmed. As more details become available, the baseline description of waste management facilities will have to be re-visited with any updates reported in an Addendum to this ESIA.

16.3.1.1.2 Fly Tipping

Roadside tipping and unlicensed disposal of wastes is common throughout the Kingdom of Saudi Arabia. Figure 16-1 shows unlicensed fly tipping found in the vicinity of the development site.

Figure 16-1: Unlicensed Roadside Fly Tipping Near Sakaka

16.3.2 Project Waste Generation

The following sections provide a summary of the estimated waste quantities that are expected to be generated during the construction, operation and decommissioning phases of the Park. These are only estimates based on the preliminary design. The final design of the Park, and the choice of technology, is likely to change and there will be a need for the Independent Power Producer (IPP) to review the types and quantities of waste generation. An Addendum to the ESIA must be prepared which details the changes and any revisions to the impact assessment.

16.3.2.1 Construction Phase

The estimated workforce during the construction phase is approximately 180 workers. Construction work hours will typically be 10 hours/day for 6 days/week with a total of approximately 240 hours/month (5 week month).

Phase one of the Park will be constructed over a period of 20 months. During this period, the following activities will take place;

- Site preparation (e.g. site grading and leveling) and site access from main road;
- Installation of temporary facilities;
- Allocation of work and laydown areas;
- Construction of internal access roads and crane pads;
- Preparation of concrete foundations for wind turbine towers;
- Assembly of wind turbine towers, nacelles and blades;
- Installation of all electrical utilities (e.g. 630 mm^3 and 300 mm^3 copper cabling, fiber optic cable); and,
- Construction of new sub-stations and connection to SEC sub-station.

Expected Waste Generation During Construction Phase

During the construction phase of the Park, a number of different types of waste will be generated. These will include non-hazardous construction wastes such as packaging and general refuse, hazardous wastes such as oils and lubricants and liquid wastes such as sanitary waste from the construction camp.

The turbine components (e.g. tower sections, nacelles, blades and transformers) will be constructed off-site and only assembled on site. This will reduce the quantities of waste generated on site during the construction phase.

Table 16-1 describes the wastes anticipated to be generated during the construction phase of the development. These quantities are estimates and will need to be reviewed by the IPP.

Table 16-1: Anticipated Construction Wastes

Waste type	Source	Classification	Estimated Quantity (t)	Destination
Inert soils, sand, rocks	Spoil from grading activities and other inert rock materials requiring removal from site.	Inert	10	Reused on site following construction
Residual construction material e.g. brick, ceramics etc.	Residual materials from construction of construction compound, O&M buildings.	Non-haz	5	Class II Landfill
Scrap Metal	Off cuts from building construction.	Non-haz	4	Class II Landfill
Scrap Metal	Off cuts from fencing.	Non-haz	2	Class II Landfill/ Recycling
Residual construction materials e.g. bolts, rebar etc.	Construction of turbine foundations and assembly of turbines.	Non-haz	10	Class II Landfill
Excess Cables	Power Transmission Cables	Non-Haz	10	Class II Landfill/ Recycling
Plastic Bottles, cans, food waste, paper etc.	Site office & Canteen waste	Non-haz	140	Class II Landfill/Recycling
Paper, Cardboard & Plastic Packaging	Materials packaging	Non-haz		Class II Landfill/Recycling
Waste Electrical & Electronic Equipment	Residual materials from installation of electrical equipment	Haz	1	Recovery/Class I Landfill
Residual construction material e.g. plaster & cement	Residual materials from construction of compounds	Haz	1	Class I Landfill
Oil contaminated wastes	Construction vehicle maintenance	Haz (liquid)	0.1	Recovery/Class I Landfill
Asphalt	Site access road	Haz	1	Class I Landfill
Paint, thinners, contaminated painting equipment, solvents etc.	Residual materials from construction of construction compounds.	Haz (liquid)	0.1	Class I Landfill
		Total Hazardous Solid Waste	3 (rounded)	
		Total Hazardous Liquid Waste	0.2 (rounded)	
		Total Non-hazardous Solid Waste	181	

16.3.2.2 Operational Phase

16.3.2.2.1 Normal Wastes

During the operation phase of the Park there will be no permanent workforce located at the Park. Security and maintenance teams will visit the site intermittently, but there will be no continuous generation of waste streams.

Waste streams generated as a result of routine maintenance will include hazardous wastes such as oils, lubricants, paints and sealants. These will be disposed of according to the guidelines laid out in IFC EHS Guidelines Section 1.5, which states that:

"Where waste generation cannot be avoided but has been minimized, recovering and reusing waste; and, where waste cannot be recovered or reused, treating, destroying, and disposing of it in an environmentally sound manner"

These wastes will be temporarily stored on site in dedicated areas which are compliant with the requirements of both the IFC and GAME for hazardous material storage prior to disposal

16.3.2.2.2 Non-Normal Wastes

There will be periodic requirements for the replacement of wind turbine components such as blades, nacelle components (gear boxes and SCADA equipment) and non-mechanical items such as bolts, ladders and doors. Due to the abnormal load and requirements of these components, they will require individually prepared management plans and appropriate risk assessment as per the requirements of IFC EHS Guidelines Section 1.6, which states that: *"waste management should be addressed through a waste management system that addresses issues linked to waste minimization, generation, transport, disposal and monitoring."*

The transportation of non-normal wastes, in particular wind turbine components (e.g. blades, tower sections) are covered in Chapter 13.

16.3.2.3 Decommissioning Phase

During the decommissioning phase of the Park, the majority of waste generated will comprise the physical structure of the Park, including wind turbines, foundations, and cabling. The decommissioning workforce is predicted to be similar to the construction workforce (i.e. 180 workers). Decommissioning work hours will typically be 10 hours/day for 6 days/week with a total of approximately 240 hours/month (5 week month)

Expected Waste Generation During Decommissioning Phase

The decommissioning phase of the Park will generate similar wastes to those expected to arise during the construction phase of the Park. In addition, there will be significant quantities of waste steel from the dis-assembly of the wind turbine towers; and composite materials associated with the nacelle covering and the turbine blades. The majority of current commercialized wind turbine blades are made from fiber-reinforced polymers (FRPs), which are composites consisting of a polymer matrix and fibers. The nacelle contains various electrical and mechanical components including motors, driver shafts, gear box, generator and brakes.

Each wind turbine will have a transformer, and these transformers will contain transformer oil, or insulating oil. Transformer oil is stable at high temperatures and has excellent electrical insulating properties and its functions are to insulate, suppress corona and arcing, and to serve as a coolant. At this stage of the design, the make and model of transformer remains to be confirmed. The choice of technology will be compliant with the International Electrotechnical Commission (IEC) standards, including the choice of transformer oil.

The decommissioning of the Park and the management of the wind turbine components, including the towers, blades and nacelles, and electrical cabling (e.g. 630 mm^3 and 300 mm^3 copper cabling and fiber optic cabling) provides significant opportunities for resource efficiency and material re-use / recycling. The Independent Power Producer (IPP) must prepare a specific management and coordination plan for the decommissioning phase of the Park to maximize opportunities for material reuse and recovery.

The foundations of the wind turbines will comprise of approximately 460 m^3 of reinforced concrete.

Table 16-2 shows wastes anticipated to be generated during the decommissioning phase of the development. These quantities are estimates and will need to be reviewed by the IPP.

Table 16-2: Anticipated Decommissioning Wastes

Waste type	Source	Classification	Estimated Quantity	Destination
Copper cabling	630 mm3 conductor cabling	Non-haz	60,845 m	Class II Landfill/ Recycling
Copper cabling	300 mm3 conductor cabling	Non-haz	76,555 m	Class II Landfill/ Recycling
Fiber optic cable	Fiber optic cabling connecting turbines to sub-stations.	Non-haz	93,830 m	Class II Landfill/ Recycling
Concrete	Foundations of wind turbines	Non-haz	144,540 t	Class II Landfill/ Recycling
Steel	Reinforced steel bars from turbine foundations	Non-haz	6,072 t	Class II Landfill/ Recycling
Steel	Wind turbine towers	Non-haz	29,400 t	Class II Landfill/ Recycling
Composite material	Wind turbine blades	Non-haz	396 no.	Class II Landfill/ Recycling These should be taken back by the manufacturer for reconditioning / material recovery.
Composite material , electrical and mechanical components	Wind turbine nacelle	Various	132 no.	These should be taken back by the manufacturer for reconditioning / material recovery.
Asphalt	Breakout of site access road	Haz	80 m^3	Class I Landfill
Aggregate materials	Sub-base of sealed and un-sealed roads, engineering fill for turbine foundations	Non-haz	102,952 m^3	Class II Landfill/ Recycling
Oil contaminated wastes	Construction vehicle maintenance	Haz (liquid)	0.1 t	Recovery/Class I Landfill
Plastic Bottles, cans, food waste, paper etc.	Site office & Canteen waste	Non-haz	140 t	Class II Landfill/Recycling
Paper, Cardboard & Plastic Packaging	Materials packaging	Non-haz		Class II Landfill/Recycling
Transformers	Transformer	Some components are hazardous (e.g. transformer oil)	160 no.	These should be taken back by the manufacturer for reconditioning / material recovery.
Fencing	Security fencing around each turbine	Non-haz	8,000 m	Class II Landfill/ Recycling

16.4 Assessment Methodology

16.4.1 Approach

The assessment of impact is based on the assumption that the IPP will comply with the IFC EHS Guidelines Section 1.5 *Hazardous Waste Management* and Section 1.6 *Waste Management* and the national requirements developed by GAME for waste collection, handling and disposal. Chapter 16 of the Environmental Impact Assessment; *Environmental Management and Monitoring Plan (EMMP)* includes details of the suggested approach to waste management.

The IPP shall ensure systems for the management of waste are implemented, audited and maintained, including the *Environmental Management and Monitoring Plan* (EMMP) and an *Environmental Emergency Response Plan* (EERP) in accordance with regulatory requirements and good industry practice. A site waste management plan should be prepared for the construction, operation and decommissioning phases of the Park. The decommissioning plan should focus on optimizing the recovery, reuse and recycling of materials to reduce the quantities that need to be sent to landfill.

Environmental management and monitoring plans should include:

- Waste and recycling objectives and targets;
- Waste segregation, storage, recycling and management procedures;
- Maximum storage times, and details of waste handling and labelling requirements;
- Selection, monitoring and auditing of waste contractors, and off site waste management facilities;
- Waste vehicle requirements;
- Competencies and training requirements of staff with responsibilities for managing waste storage areas;
- Procedures and lines of communication to be followed in the event of an emergency (including accidental releases of hazardous substances);
- Procedures to be implemented following an accidental release of hazardous substances, including details of containment and recovery measures to be applied; and,
- Procedures for the monitoring of waste generation, and collection and reporting of data on this.

It is the responsibility of the IPP to ensure that staff are trained on the on-site waste management systems (as appropriate), use of spill mitigation materials and equipment, and procedures to be followed in the event of emergency incidents, such as accidental releases of hazardous substances.

It is also recommended that the IPP undertake regular audits of the above management plans, to confirm their ongoing effectiveness.

16.5 Impact Assessment

16.5.1 Construction Phase

The potential environmental impacts that could result directly from waste management relate to the potential releases of waste substances, the hazards presented by such releases and the effect that the releases may have on the environment and human health. The principal releases associated with waste management are liquid and solid discharges to land and water.

This section describes and assesses the impact on existing waste management systems and those resulting from the generation of waste by the project during construction, operation and decommissioning. Potential impacts from leaching and spillage are assessed in Chapter 7: *Soils and Geology* and potential impacts on habitat are assessed in Chapter 11: *Biological Resources*.

In addition to release, the generation of waste during the construction, operation and decommissioning phases of the Park has the potential to impact on the operational capacity of existing landfill and waste management infrastructure within the Al Jouf Province.

Table 16-3: Impact Assessment During Construction and Commissioning

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
WM1	Human beings and the environment	Moderate	On site storage and offsite disposal of non-hazardous waste generated during construction	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Infrequent Duration: Medium Extent: Local Permanence: Reversible	Low	Low
WM2	Human Being & Environment	Moderate	On site storage and offsite disposal of hazardous waste generated during construction	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Infrequent Duration: Medium Extent: Local Permanence: Reversible	Low	Low
WM3	Waste Management Infrastructure	Moderate	Exceedance of operational capacity at local waste management facilities.	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Infrequent Duration: Medium Extent: Local Permanence: Reversible	Low	Low

16.5.1.1 Storage and Disposal of Non Hazardous Wastes

The estimated quantity of non-hazardous waste generated during the construction phase is expected to be 181 tons over the 20 month construction period, equivalent to approximately 110 tons per year. Non-hazardous solid wastes may cause contamination of soil environment or potential human health impacts if stored or disposed of improperly. The non-hazardous wastes derived from the construction activities will be stored temporarily on site prior to being disposed of in an authorized GAME Sanitary Landfill – Class II.

Specific details of the waste storage (and where possible, reuse on site in the case of soils) conditions and management at the Park will be specified by the IPP during the detailed engineering phase, and a Construction Site Waste Management Plan will be developed. The plan will be prepared in accordance with the recommendations of GAME and the IFC, in order to minimize the potential for impacts to occur.

The magnitude of impacts related to on-site storage and disposal of non-hazardous waste during the construction phase, on human health and the environment, is expected to be low, given the type of the materials involved (non-hazardous, short term effect), on-site storage duration, and the assumption that the on-site storage, transfer and ultimate disposal of such non-hazardous wastes will be undertaken in accordance with GAME Environmental Standard 13 *Waste Handling & Storage* and Sections 1.5 Hazardous Materials Management and 1.6 Waste Management of the IFC EHS Guidelines (2007). In accordance with Section 1.6, waste management should be addressed through a waste management system that addresses issues linked to waste minimization, generation, transport, disposal and monitoring.

Considering the sensitivity of the receptor, the significance of impacts on human beings and the environment, from non-hazardous waste generation during construction, is expected to be low.

Impact WM1 – Low Significance

16.5.1.2 Storage and disposal of hazardous wastes

The quantity of hazardous wastes generated during construction is likely to be 3.2 tons. Solid waste streams mainly relate to empty chemical/paint containers and asphalt from the road construction. Liquid waste streams relate mainly to fuel and fluids required for machinery operation such as diesel, greases, lubricants and oils.

Hazardous wastes generated during the construction and commissioning phases of the Park have the potential to cause significant harm to human and environmental receptors through direct contact, discharge, leaks and spills.

The hazardous wastes derived from the construction activities will be stored temporarily on site prior to being disposed of in an authorized GAME Sanitary Landfill – Class I. The Contractor will be required to prepare and implement an emergency response procedure which is compliant with both the GAME and IFC regulations, in line with the EERP developed as part of this EIA, to ensure that accidental discharges of hazardous waste are promptly contained and the wastes and any control materials disposed of correctly. The magnitude of the impacts related to accidental discharge of wastes leading to impacts on human health and the environment is expected to be low during construction given the small quantity of materials involved and the assumption that the on-site storage transfer and ultimate disposal of such wastes will be undertaken in accordance with the GAME and IFC Environmental Standards. Therefore, considering the sensitivity of the receptor the significance of impacts on human beings and the environment from hazardous waste generation during construction is expected to be low.

Therefore, considering the sensitivity of the receptor the significance of impacts on human beings and the environment from hazardous waste generation during construction is expected to be low.

Impact WM2 – Low Significance

16.5.1.3 Exceedance of operational capacity at local waste management facilities

At this stage the capacity and availability of existing waste management infrastructure remains uncertain, although the Ministry of Municipalities and Rural Affairs has provided details of the municipal landfill located to the south of Sakaka. Based on the information provided, this facility has capacity to receive non-hazardous waste generated during the construction phase of the Park. It remains uncertain whether this facility can receive hazardous waste, however only a small quantify of hazardous waste is expected to be generated during the construction phase of the Park. It has therefore reasonably been assumed that there is a facility in Al Jouf Province that can receive this quantity.

Although there remains some uncertainty of the capacity of local waste management infrastructure, sufficient information has been provided and this impact is assessed as low in the absence of mitigation.

Impact WM3 – Low Significance

16.5.2 Operation Phase

There will be no permanent workforce located on site at the Park, and vehicle movements will be restricted to intermittent security and maintenance teams using small vehicles (e.g. pick-ups). During routine operations, there is no predicted significant impact on the existing waste management infrastructure. Principally due to the low volumes of waste generated. In the event of a major failure and the requirement to replace significant components (i.e. blades, nacelles and the associated electrical and mechanical components), there is an increased likelihood of waste generation that will require management. However, it is anticipated that these valuable components would be taken back by the turbine supplier for repair or recycling rather than being sent to landfill. This is not considered to be a routine operation and is further considered in Chapter 21 *Environmental Emergency Response Plan*.

Table 16-4 : Impact Assessment During Operation

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
WM4	Waste Management Infrastructure	Moderate	Exceedance of operational capacity at local waste management facilities due to excess 'Normal' waste generated during operation of the Park	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Infrequent Duration: Short Extent: Local Permanence: Reversible	Low	Low
WM5	Waste Management Infrastructure	Moderate	Exceedance of operational capacity at local waste management facilities due to excess 'Non-Normal' waste generated during operation of the Park	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Infrequent Duration: Short Extent: Local Permanence: Reversible	Low	Low

16.5.2.1 Exceedance of operational capacity at local waste management facilities due to excess 'Normal' waste generated during operation of the Park

Normal waste is classified as waste which would be expected to be generated during normal operation of a facility. This includes non-hazardous items such as office consumables and hazardous items such as paints, lubricants and sealants used during routine maintenance of wind turbines. Due to the fact that no operational staff will be located at the Park, a very low quantity of office waste is expected to be generated during operation of the Park. Despite the moderate sensitivity of local waste infrastructure, it is anticipated that suitable capacity would be present to receive these very small quantities of waste.

Hazardous wastes such as paints, lubricants and sealants will be managed and disposed of in line with the waste management requirements of GAME and the IFC.

Due to the low quantities of waste expected to be generated, and the proposed management structure, this impact is considered to be of low significance.

Impact WM4 – Low Significance

16.5.2.2 Exceedance of operational capacity at local waste management facilities due to excess 'Non-Normal' waste generated during operation of the Park

Non-normal waste includes components such as wind turbine blades, nacelle components and SCADA equipment. These items will require specialized transport, management and disposal. Furthermore, it is anticipated that any failed components would be returned to the manufacturer for repair and refurbishment. It is therefore not expected that the disposal of these wastes would impact upon local waste management infrastructure.

Due to the intention to return these items to manufacturers for refurbishment, this impact is considered to be of low significance.

Impact WM5 – Low Significance

16.5.3 Decommissioning Phase

Impacts experienced during the decommissioning phase of the Park are expected to be similar to those experienced during the construction phase.

Table 16-5: Decommissioning Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
WM6	Waste Management Infrastructure	Moderate	Exceedance of operational capacity at local waste management facilities (e.g. excess waste generated through demolition of buildings/breaking up of concrete at development site).	Effect: Negative Action: Direct Likelihood: Likely Frequency: Infrequent Duration: Medium Extent: Local Permanence: Reversible	Moderate	Moderate

16.5.3.1 Exceedance of operational capacity at local waste management facilities

Significant quantities of materials will be generated during the decommissioning of the Park (Table 16-2). Although some of these materials will include typical construction debris (i.e. concrete, asphalt, aggregates), some will comprise of specialized and highly engineered components associated with the turbines and associated infrastructure (e.g. turbine towers, turbine blades, nacelles and associated equipment, transformers, copper cabling). These materials are highly valuable and it is possible that these components could be reconditioned/re-used/recycled and maximize resource efficiency by reducing the quantities of material sent to landfill.

A decommissioning Site Waste Management Plan will be developed by the IPP. The plan will be prepared in accordance with the recommendations of GAME and IFC in order to minimize the potential for impact. The plan must maximize opportunities for resource efficiency and pollution prevention in accordance with IFC Performance Standard 3 and the IFC EHS Guidelines. This includes the crushing and recycling of concrete foundations and the reuse of aggregates used in the sub-base of internal access roads.

The decommissioning waste management plan must engage and consult with key stakeholders to ensure all the opportunities for reusing and recycling decommissioning wastes are identified.

Prior to the decommissioning of the transformers, the transformer oil should first be drained. This will minimize the risk for accidental spills and leaks during removal from the site and transit to receiving location. Transformer oil is classified as a hazardous waste and this must be disposed of by a fully licensed and approved waste management contractor and facility.

At this stage the capacity and availability of existing waste management infrastructure remains uncertain, although the Ministry of Municipalities and Rural Affairs has provided details of the municipal landfill located to the south of Sakaka. However it is unknown whether this facility has adequate recycling facilities and can contribute to towards the objectives of resource efficiency.

There remains some uncertainty of the capacity of local waste management infrastructure to adequately manage decommissioning wastes. Due to this uncertainty, the precautionary approach has been adopted. This impact is assessed as moderate in the absence of mitigation.

Impact WM6 - Moderate Significance

16.6 Mitigation and Recommendations

Mitigation measures to be implemented at the Park are focused around the preparation and implementation of appropriate waste management plans. These plans will identify approved waste management contractors and waste management facilities and recommend measures to optimize material reuse and recycling. The IPP should promote material take-back initiatives for specialist components, including wind turbine towers, nacelles, blades and transformers.

Table 16-6: Mitigation Measures

ID	Potential Significance	Mitigation Measures	Residual Significance
WM6	Moderate	Contractor to prepare a decommissioning site waste management plan in consultation with local stakeholders, waste management contractors and equipment suppliers (i.e. suppliers of wind turbines). The residual significant remains the same until the approaches to waste management are confirmed and it can be confirmed that local waste management infrastructure has capacity to receive wastes from the decommissioning of the Park.	Moderate

In addition to the specified mitigation, it is recommended that the IPP prepare a construction, operation and decommissioning site waste management plan which is fully compliant with the requirements of GAME and the IFC EHS Guidelines. The contents of the plan and the aspects that the plan should address are specified in Section 16.2.

16.7 Conclusion

This Waste Management impact assessment has been based on a precautionary approach using data from desk-based review and current available design assumptions. As the design progresses and more details become available, the assessment will have to be re-visited with any updates reported in an Addendum to this ESIA.

The main impacts on waste management infrastructure are expected to occur during the construction and decommissioning phases of the Park and will be associated with the use of hazardous and non-hazardous construction materials. Limited waste is expected to be generated during the operational phase of the Park. Construction phase impacts are assessed as low significance.

At this stage the capacity and availability of existing waste management infrastructure remains uncertain, although information has been provided on the municipal waste landfill to the south of Sakaka. The understanding of local waste management infrastructure is subject to further stakeholder consultation by the IPP. It has been assumed that this municipal landfill can accommodate non-hazardous waste generated during the construction phase of the project, and that there is a facility within Al Jouf which can receive the small quantities of hazardous waste.

However the decommissioning phase will generate specialist waste streams and it is not certain whether the existing infrastructure can receive and recycle these waste streams in accordance with the objectives of IFC Performance Standard 3 *Resource Efficiency and Pollution Prevention.* As such, there is a potential for exceedance of operational capacity. Further consultation by the IPP with the local stakeholders will confirm the operational capacity of waste management infrastructure with the aim of reducing the residual impact to low. However, in the interim, impacts of moderate significance are predicted for the decommissioning phase.

16.8 References

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17. Health and Safety Aspects

17.1 Introduction

This chapter presents a description of the potential health and safety issues associated with the Dumat Al Jandal Wind Energy Park (the Park), an overview of the international and national health and safety legislation and standards, and information regarding regional and local health infrastructure.

Baseline health data are presented for the Kingdom of Saudi Arabia as a whole and the Al-Jouf Region in which the Park is located. The baseline gives an understanding of the overall context of health issues and provides a basis for the evaluation of potential impacts in relation to health and safety for the construction, operation and decommissioning phases of the Park.

The World Health Organization defines health as: *"A state of complete physical, mental and social well-being, and not merely the absence of disease"*. It also states that *"Good health is essential to human welfare and to sustained economic and social development"*.

The maintenance of a good health status is promoted within the Qur'an. Hygiene is a prominent topic in Islam, and the Qur'an advises Muslims to uphold high standards of physical hygiene whenever possible. The health sector is a key priority of the Government to provide all Saudi citizens and residents with access to free and high standards of health care.

17.2 International and National Standards and Guidance

This section sets out the international development standards set by the World Bank Group (including the IFC), national legislation and regulatory standards which have informed the assessment of impacts on health and safety.

17.2.1 World Bank and IFC Performance Standards

The World Bank has defined the principles for the assessment of health in Environmental and Social Impact Assessment. Guidance is provided through the Environmental Assessment Sourcebook (2007) for the systematic integration of public health and safety concerns through early screening of proposed developments and implementation of appropriate measures to address risks during project preparation, implementation, and beyond.

Health aspects of particular interest are the potential risks associated with communicable and non-communicable diseases, accidents and injury, malnutrition (direct and indirect through land-use change), health infrastructure and the impact of the project on its capacity, integration into the project design, and monitoring of potential effects.

The IFC has produced a series of performance standards (as described in Chapter 2 Policy, Legal and Administrative Framework) which highlight the importance of health and welfare in Environmental and Social Sustainability. The following performance standards are particularly relevant to this chapter:

- IFC Performance Standard 1 (2012) – Assessment and Management of Environmental and Social Risks and Impacts;
- IFC Performance Standard 2 (2012) – Labor and Working Conditions; and,
- IFC Performance Standard 4 (2012) – Community Health, Safety and Security.

16.8.1.1 IFC Performance Standard 2

Performance Standard 2 requires the adoption of human resources policies and procedures to provide workers with clear documented information as to their rights under National Labor Laws and any relevant collective agreements. These include their rights relating to working hours, wages, overtime, compensation, breaks, rest days, and any benefits including leave for illness, maternity leave, annual and statutory holidays etc.

Where accommodation is being provided, policies on the quality and management of the facilities should be implemented to ensure the provision of basic services which are defined as:

- Minimum space;
- Supply of water;
- Adequate sewage and waste disposal;
- Protection against heat, cold, damp, noise, fire, and disease carrying animals;
- Adequate sanitary and washing facilities;
- Cooking and storage facilities;
- Natural and artificial lighting; and,
- Basic medical services where appropriate.

The accommodation should also not restrict workers' freedom of movement or of association with other workers.

16.8.1.2 IFC Performance Standard 4

IFC Performance Standard 4 (2012) has the following objectives:

- *To anticipate and avoid adverse impacts on the health and safety of the affected community during the project life from both routine and non-routine circumstances; and,*
- *To ensure the safeguarding of personnel & property is carried out in accordance with relevant human rights principals and in a manner that avoids or minimizes risks to the affected communities.*

The implementation of the actions required to comply with this standard is managed through the Environmental and Social Management System (ESMS) outlined in IFC Performance Standard 1. The Standard requires the evaluation of the risks and impacts to the Health and Safety of any affected communities during construction, commissioning, operation and decommissioning. Measures to prevent, minimize and manage these risks in line with international best practice are required to be implemented, and any mitigation measures should be commensurate with the nature and magnitude of the impact. Importantly, the standards call for the avoidance of risks and impacts over minimization and mitigation. The standard highlights the following aspects:

- Infrastructure and Equipment Design and Safety;
- Hazardous Materials Management and Safety;
- Ecosystem Services;
- Community Exposure to Disease; and,
- Emergency Preparedness and Response.

The Performance Standard also provides guidance on the minimum requirements where security personnel are employed as part of the project (either directly or through contract). The requirements cover hiring, training, equipping, use of force, conduct towards affected communities, and monitoring. It also requires compliance with the United Nations (UN) Code of Conduct for Law Enforcement Officials, and the UN Basic Principles on the use of Force and Firearms by Law Enforcement Officials. A grievance mechanism is required to be provided for all parties.

16.8.1.3 IFC Environmental, Health and Safety Guidelines

In addition, the IFC has produced Environmental, Health and Safety (EHS) Guidelines (2007) which detail specific requirements for Occupational and Community Health, Safety and Welfare. The document sets out the minimum requirements for compliance with international best practice, provides exposure limits for noise, radiation and other factors, and details minimum expectations for the provision of welfare facilities on site, and in accommodation camps. The guidelines also detail recommendations for the protection of workers and the community against the transmission of diseases, including the provision of screening and vaccination programs.

Sector EHS guidelines have been developed to address particular aspects associated with different types of development. Of particular relevance to the Park are:

- IFC EHS General Guidelines (2007).
- IFC EHS Guidelines for Electric Power Transmission and Distribution (2007).
- IFC EHS Guidelines for Water and Sanitation (2007).
- IFC EHS Guidelines for Wind Energy (2015).

The IFC EHS *Guidelines for Wind Energy* (2015) include information relevant to environmental, health, and safety aspects of onshore and offshore wind energy facilities. The guidelines cross refer to the IFC EHS *General Guidelines*, which provide more general detail of health and safety hazards such as fire precautions, first aid, area signage etc. The IFC EHS *Guidelines for Wind Energy* (2015) states that occupational health and safety hazards during the construction, operation, and decommissioning of wind energy facilities can include, but are not limited to, the following:

- Working at Height;
- Working over Water;
- Working in Remote Locations; and,
- Lifting Operations.

Community health and safety hazards during the construction, operation, and decommissioning of onshore and offshore wind energy facilities are also considered within the *Guidelines for Wind Energy* (2015). More general community health and safety issues, such as structural safety of project infrastructure and disease prevention, are set out in the IFC EHS *General Guidelines.* Hazards set out in the *Guidelines for Wind Energy* (2015) relevant to the Park and this chapter include the following:

- Blade and Ice Throw;
- Aviation;
- Electromagnetic Interference and Radiation; and,
- Public Access.

16.8.1.4 IFC and European Bank for Reconstruction and Development (EBRD) guidance note: Worker's Accommodation

The IFC with the European Bank for Reconstruction and Development (EBRD) have published the guidance note: Worker's Accommodation: Process and Standards (IFC 2009) with associated checklist which details the level of required facilities, layout and expectations for the provision of all workers accommodation both during construction and operation.

The performance standard also states the minimum expectations under Occupational Health and Safety for employees, third party contractors, and workers in the supply chain. The standard requires the implementation of policies and procedures to good international industry practices which minimize the risks to workers from hazards including physical, biological, chemical, radiological and specific threats to vulnerable groups. The procedures should include the identification of hazards, their prevention or protective measures, reporting and documentation of accidents, diseases and incidents, and emergency preparedness. Training of workers should also be undertaken.

Policies and procedures should also be developed and implemented for the management and monitoring of third party contractors and the primary supply chain, and incorporate these where appropriate into their contractual obligations.

17.2.2 The Equator Principles

The Equator Principles are a set of ten ethical lending principles which are aligned with the IFC Performance Standards, and require the implementation of the IFC EHS guidelines as a minimum standard for all financed projects in non-designated countries. Key Equator Principles of relevance to this assessment include:

- Principle 4: *Environmental and Social Management System and Equator Principles Action Plan - projects that will have potential social risks are required to develop or maintain an Environmental and Social Management System (ESMS) to manage risk.*
- Principle 5: *Stakeholder Engagement - clients should undertake an ongoing process of stakeholder engagement with affected communities to ensure the risk and impacts of a project are managed as far as reasonably practicable.*
- Principle 6: *Grievance Mechanism – clients are required, as part of the ESMS, to establish a grievance mechanism designed to receive and facilitate resolution to any concerns and grievances about a projects social performance from affected communities.*

17.2.3 National Labor Law

Royal Decree No. M/51, 27 September 2005 is the principal legislation defining the occupational health and safety rights of all workers within the Kingdom of Saudi Arabia. The law sets out provisions concerning workers' rights in terms of pay, welfare, working hours and conditions and access to healthcare. Part VIII of the law sets out provisions for the protection against occupational hazards, major industrial accidents and work injuries, as well as health and social services.

17.2.4 General Authority for Meteorology and Environment (GAME) Environmental Standards

As identified in chapter 2 of this report, the General Administration for Meteorology and Environment (GAME) (formerly the PME)) is responsible for issuing consent for projects to ensure compliance with the Public Environment Law and implementing regulations. Particular reference should be made to the General Environmental Regulations and Rules for Implementation (GERRI) which were enacted in 2001. Of particular relevance to this chapter is Article 2 of the GERRI which includes the aim to *'protect public health from activities and acts that harm the environment'*.

The GAME defines, through a series of standards, thresholds and criteria, measures to protect public and employee health from harmful air quality emissions, noise, contaminant and pollution sources (both land and water), and disposal of hazardous waste materials.

The regulations are supported by a series of Environmental Standards on air quality, noise, waste management, water quality (including drinking water), and the prevention of major accidents.

The GAME requires the facilities to be designed to meet these standards, and exemptions can only be provided by the relevant minister. Compliance with the standards through design, therefore, automatically confers a level of protection for public and employee health.

Environment Standard 5 – *Prevention of Major Accidents*, defines the requirements for developing, implementing, reporting and monitoring both an off-site and on-site emergency response plan which should be reviewed as a minimum every two years during construction and operation of the facility.

17.2.5 Ministry of Transport

"Exceptional Loads" 01-77, dated 7-5-1432 (corresponding to 7th May 2011)

This document outlines the MOT permitting requirements for transporting exceptional loads and the specifications which constitute such a load. Requirements are laid out which must be fulfilled in order to obtain a permit. These include:

- Specifications of vehicles.
- Description of the load to be transported.

- The pre-submission time required to obtain a permit.

The standard also outlines commitments which must be met by the driver of the vehicle. These include:

- Commitment to follow the pre designated and approved route.
- Commitment to adhere to a pre designated and approved speed limit.

Permits, once issued, are valid for one trip, must be used during daytime hours only, and may not be used over weekends or public holidays.

17.3 Baseline Environmental Conditions

The baseline conditions for the Al-Jouf Region have been identified through a desk-based review using statistics and datasets available on the Kingdom of Saudi Arabia's government Statistical Yearbook of 2015, which is available on the General Authority for Statistics website (https://www.stats.gov.sa/en/4515 [Accessed May 2017]).

The Study Area has focused on Dumat Al Jandal and the Al-Jouf Region in which the Park would be located.

17.3.1 Healthcare in the Kingdom of Saudi Arabia and the Al-Jouf Health Region

The Kingdom of Saudi Arabia has an estimated population of over 31 million[8] with an approximate annual growth rate of 2.1 %[9]. The population is spread between 150 cities and more than 2000 villages, often located in remote areas. The provision of Health Services in the Kingdom of Saudi Arabia falls under the remit of the Ministry of Health (MOH). The MOH operates a three tier approach to healthcare provision:

- Primary: Health Centers;
- Secondary: General Hospitals; and,
- Tertiary: Specialist Hospitals.

The MOH provides approximately 60 % of healthcare facilities, with the remainder being provided by other ministries with specific healthcare duties to discharge (e.g. Ministry of Defense, National Guard, Ministry of Interior, Ministry of Higher Education), with some private healthcare providers, and the King Faisal Specialist Hospital.

The MOH has published a ten year health care strategy (2009/10 to 2019) for the Kingdom of Saudi Arabia, to provide a patient centered healthcare service to meet *"patients' health needs in the right place at the right time"*. The strategy provides for (and protects) the patients' right to know and choose their health care treatment and provider, and is implemented through the MoH Integrated and Comprehensive National Healthcare Project.

Table 17-1 provides a summary of the health infrastructure within the Kingdom of Saudi Arabia and the Al-Jouf Region based on datasets from the 2015 Health Statistics Yearbook.

Table 17-1 : MOH Health Infrastructure Data

MoH Health Infrastructure	Kingdom of Saudi Arabia (population 31,521,418)	Rate per 10,000 people	Al-Jouf Health Region (population 336,957)	Rate per 10,000 people
Number MOH Hospitals	274	0.1	8	0.2
Number MOH Beds	41,297	13.1	1280	38

[8] General Authority for Statistics, General Population and Housing Census, Population In The Kingdom by Single Age , Nationality (Saudi/Non-Saudi) and Gender In Mid-Year 2015 A.D

[9] World Bank Group, Population growth (annual %), Overview for Saudi Arabia: http://data.worldbank.org/indicator/SP.POP.GROW?locations=SA

MoH Health Infrastructure	Kingdom of Saudi Arabia (population 31,521,418)	Rate per 10,000 people	Al-Jouf Health Region (population 336,957)	Rate per 10,000 people
Number Physicians (including dentists)	41,240	13.1	874	25.9
Number Nurses	95,379	30.3	3049	90.5
Number Pharmacists	3,184	1.0	58	1.7
Number Allied Health Personnel	55,080	17.4	1136	33.7
Health Centers	2,282	0.7	40	1.2

Approximately 32.6 % of the physicians (including dentists) and 60 % of the nurses are Saudi Nationals. 31 % of physicians, 74 % of nurses, 36 % of pharmacists, and 23 % of allied health personnel are female.

Each primary health care center provides services to an average of 13,813 people across the Kingdom of Saudi Arabia. Within the Al-Jouf Health Region each health care center provides services to an average of 8,424 people.

17.3.2 Communicable and Infectious Diseases

A comprehensive vaccination program over the last 20 years has been undertaken in the Kingdom of Saudi Arabia. Vaccination coverage was 97.6 % for measles, mumps and rubella in 2014, and 98.3 % for diphtheria, pertussis, tetanus, poliomyelitis (polio) and hepatitis B.

There have been no cases of polio, yellow fever, Rift Valley fever or plague between 2011 and 2015. There were three cases of rabies in 2015 but none in the previous four years.

The total number of new cases of pulmonary tuberculosis (TB) in 2015 was 2505 with an overall incidence rate of 7.95 cases/ 100,000 population, this reflects minimal increase compared to the figure reported in the previous year. There has been an improvement in case reporting and notification as well as health education programs including the World Day of TB. Total cases of non-pulmonary tuberculosis reached 841 with an overall incidence rate of 2.67/100,000 of the population. Table 17-2 sets out the incidence rate (per 100,000 people) of certain notifiable communicable diseases between 2011 and 2015. For most diseases, the Al-Jouf Region has much lower incidence rates, the exception being Brucellosis, where the rate was 44 % higher than the Kingdom of Saudi Arabia average for 2015.

Table 17-2 : Incidence Rates (Per 100,000 Persons) of Certain Notifiable Communicable Diseases across the Kingdom of Saudi Arabia 2011 - 2015 and Al-Jouf Health Region 2015 (MoH 2016)

Disease	2011	2012	2013	2014	2015	Al-Jouf Region 2015
Amoebic dysentery	7.00	7.44	6.06	7.73	5.98	0.00
Brucellosis	13.89	12.54	10.88	10.11	10.26	14.83
Chickenpox	68.61	64.06	36.45	26.66	18.97	1.48
Dengue fever	11.64	5.99	21.71	6.76	13.68	0.00
Diphtheria	0.0120	0.000	0.030	0.010	0.013	0.00
Hepatitis A	1.13	1.06	0.79	0.42	0.40	0.00
Hepatitis B	15.84	15.79	14.20	14.05	11.06	4.45

Disease	2011	2012	2013	2014	2015	Al-Jouf Region 2015
Hepatitis C	8.20	8.01	5.26	5.48	4.21	1.78
Measles	1.28	1.01	0.84	0.50	0.69	0.89
Meningococcal meningitis	0.02	0.01	0.01	0.01	0.02	0.00
Meningitis pneumococcal	0.04	0.01	0.01	0.01	0.02	0.00
Meningitis haemophilus	0.000	0.000	0.010	0.000	0.010	0.00
Mumps	0.09	0.22	0.12	0.06	0.01	0.00
Pulmonary tuberculosis	9.31	8.83	8.16	7.59	7.95	1.48
Rubella	0.00	0.06	0.22	0.07	0.02	0.00
Tetanus neonatorum	0.03	0.02	0.02	0.00	0.002	0.00
Tetanus, other types	0.04	0.02	0.06	0.04	0.03	0.00
Typhoid and paratyphoid	1.03	1.01	0.75	0.39	0.47	0.00

Malaria is present across the Kingdom of Saudi Arabia, however there is a wide regional variation in cases. Anti-malaria programs, which include spraying, have been in place since 1948. A total of 2,620 cases of malaria were notified in 2015. The regions with the highest number of malaria cases are Jazan (984 cases in 2015) and Eastern (427 cases in 2015). There were 9 notified malaria cases in Al-Jouf Region. The source of these cases is not known (e.g. brought into the Kingdom of Saudi Arabia through the movement of migrant workers).

17.3.3 Non-Communicable Diseases

According to the World Health Organization (WHO 2014), non-communicable disease account for 78 % of all deaths in the Kingdom of Saudi Arabia see Figure 17.1. Cardiovascular disease accounts for the largest proportion at 46 %.

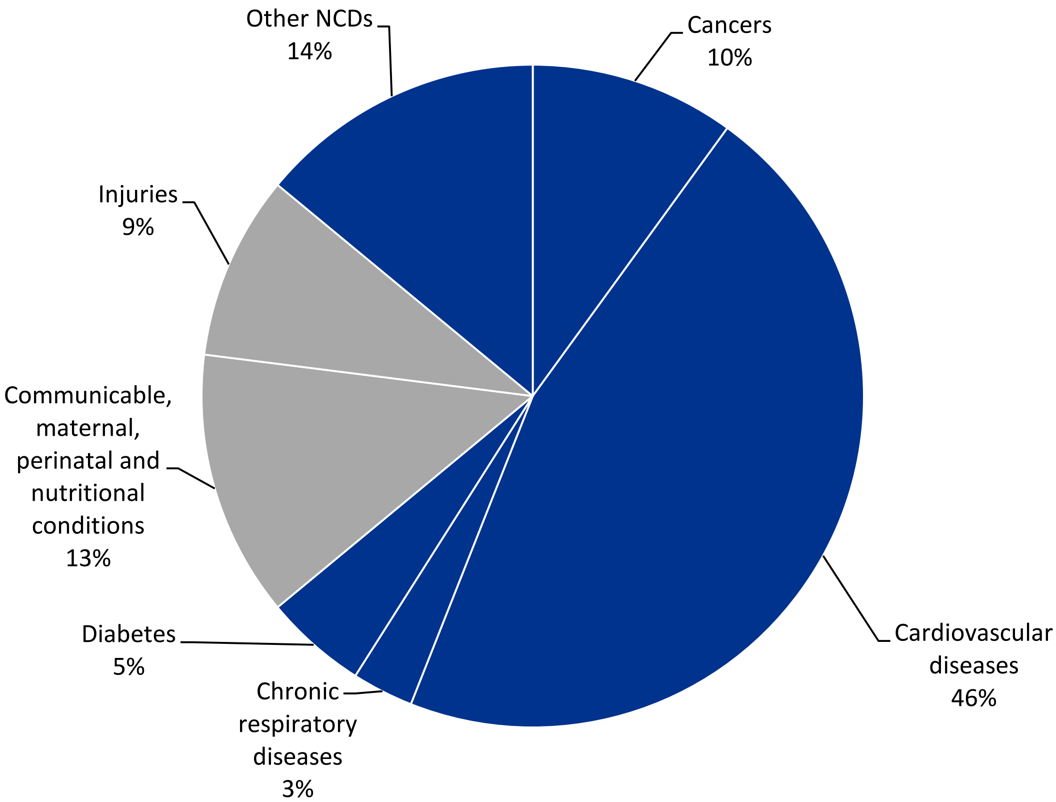


Figure 17.1 : Proportion of total deaths in the Kingdom of Saudi Arabia for all age groups (WHO 2014)

17.3.4 Occupational health and accidents

Occupational Health in the Kingdom of Saudi Arabia is aimed at the prevention, treatment and monitoring of work related injuries and diseases. The General Organization for Social Insurance (GOSI) for Saudi Arabia is responsible for the protection of workers, treating and compensating work injuries under the Occupational Hazards Branch (OHB), developing and updating schedules of occupational diseases in accordance with relevant international laws and legislation, and preparing the Annual Statistical Report on the occupational injuries in the Kingdom of Saudi Arabia.

Work related injuries decreased steadily between 2005 and 2013, but show a fairly substantial upturn in 2014 (see Figure 17.2).

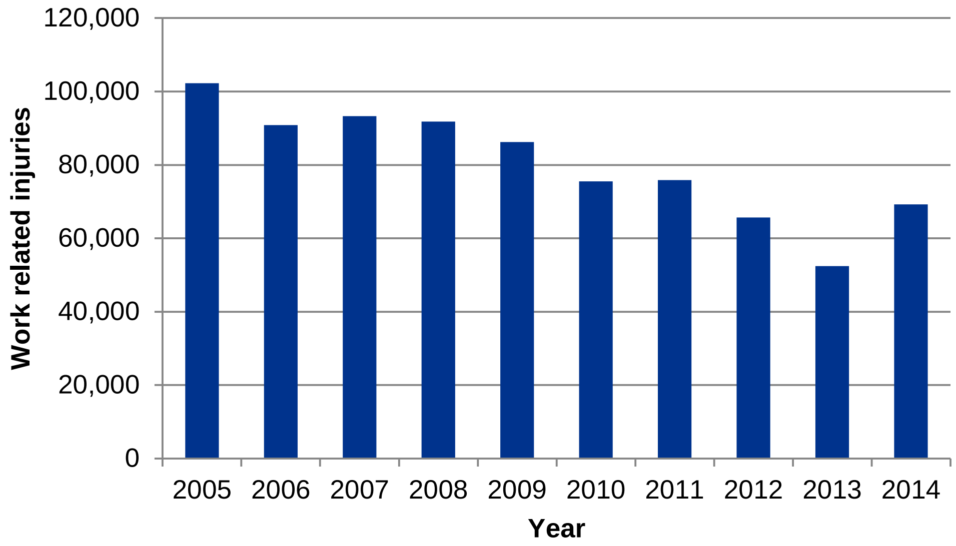
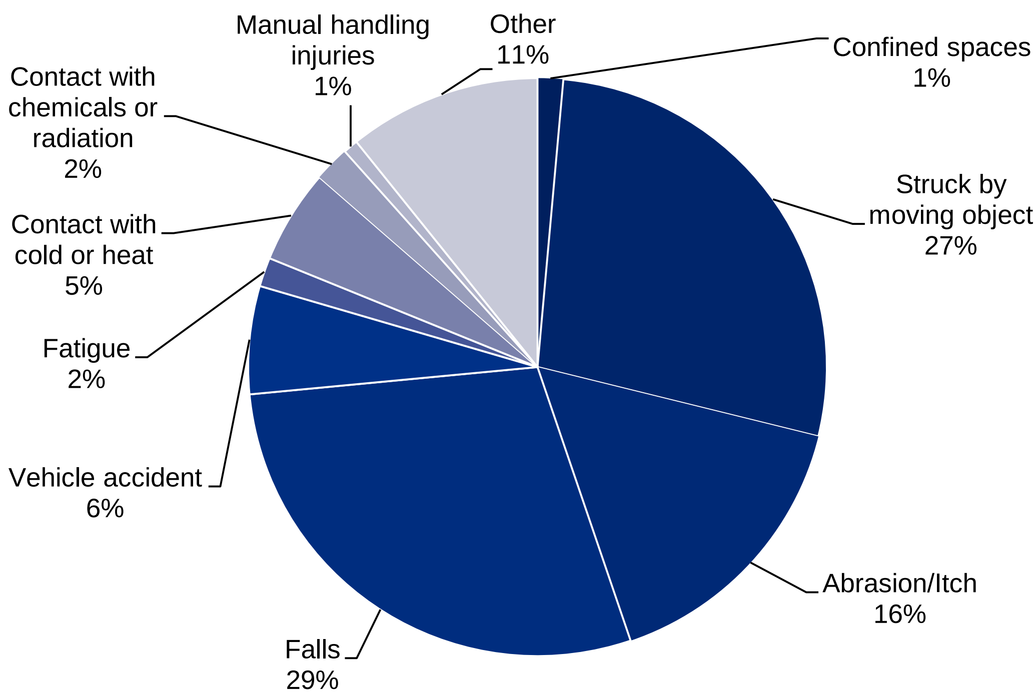


Figure 17.2 : Work related injuries in the Kingdom of Saudi Arabia

A total of 69,241 cases of work related injuries were reported in the Annual Statistical Report for 2014[10], of which only 5.4 % occurred to Saudi nationals. The majority of injuries (51.3 %) occurred within the construction industry, with a further 18.7 % within the building services trade and 16.5 % within transformative industries. The remaining industries (trade, mining and quarrying, social services, agriculture and fishing, electricity and water, financing and real estate) each comprised less than 5 % of reported injuries. The leading causes of injuries were falls, collisions and rubbing or abrasion (see Figure 17.3). The significant majority of injuries recorded were recovered without disability, however 10.9 % were recovered with disability and 1.5 % resulted in death.



[10] The latest available report at the time this assessment was prepared

Figure 17.3 : Causes of work related injuries

Road traffic accidents are known to be high in the Kingdom of Saudi Arabia compared to western countries. Collision rates increased sharply from approximately 280,000 in 2006 to 435, 000 in 2007, and have continued to exceed 400,000 in the following years (Figure 17.4). Rates of injury and fatalities have remained relatively stable or gently increasing. DeNicola et al (2016) report 545,000 collisions in 2011, resulting in more than 40,000 injuries (7.3 %) and approximately 7000 deaths (1.3 %). For context, the number of registered vehicles in the Kingdom was circa 6.5 million in 2010 and 8 million in 2013 (data for 2011 not available).

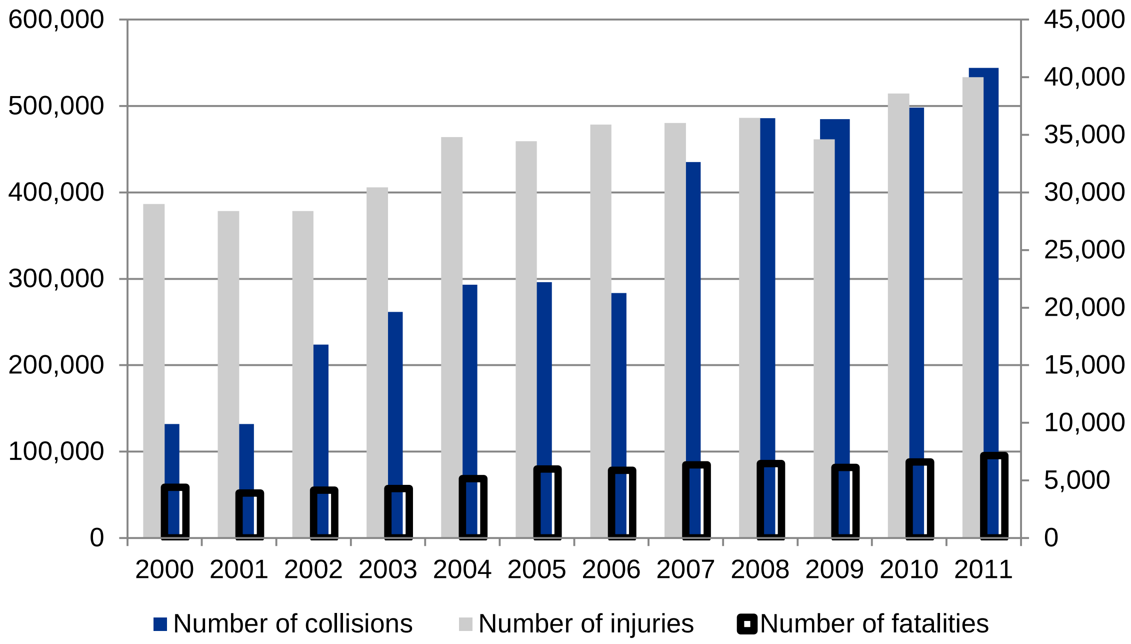


Figure 17.4 : Annual data for road traffic collisions and resultant injuries and fatalities (data from DeNichola et al. 2016)

17.3.5 Local Healthcare Facilities

Doma General Hospital is located within Dumat Al Jandal. The hospital is the main hospital for Dumat Al Jandal, and includes an accident and emergency center.

The Prince Mohammed Medical City is currently under construction in Sakaka, 35 km east of Dumat Al Jandal, with the aim of providing tertiary healthcare services to the two million inhabitants of the Al-Jouf, Tabuk, Hail and the Northern Borders Regions. The Prince Mohammed Medical City is being delivered in two main phases and once complete will provide over 1000 beds. The Medical City will include the following centers providing the following specialist services:

The first phase of the Prince Mohammed Medical City, which will be the main hospital with 500 beds, was anticipated to be complete and ready to take patients in April 2017. The status of this hospital is currently unknown.

The second phase will see the delivery of the following specialist centers and hospitals, and is due for completion in April 2019:

- Ophthalmology Hospital;
- Rehabilitation Hospital;
- Oncology Center;

- Cardiology Center; and,
- Neuroscience Center.

17.4 Assessment Methodology

17.4.1 Approach

The impact assessment has been completed in accordance with the methodology outlined by Chapter 5 - *Impact Assessment Methodology*.

The assessment considers the potential impacts, both negative and positive, that the Park may have on the health, safety and welfare of both the employees and the local communities. Consideration has been given to impacts associated with the construction, operation and decommissioning phases of the Park.

17.4.2 Sensitive Receptors

The identification of sensitive receptors has been based on assumptions made relating to the likely geographical influence of the Park, and the pathways to which potential impacts could occur on people within the geographical area of influence. The identification of sensitive receptors is set out in Table 17-3. Unless otherwise stated, all receptors are considered to have 'high' sensitivity.

Table 17-3 : Sensitive Receptors for Health and Safety

Sensitive Receptors	Location
Construction workers involved in enabling works (pre-construction activities)	Dumat Al Jandal Wind Energy Park
Construction workers involved in main construction phase	Dumat Al Jandal Wind Energy Park
Road users along transport routes	Transport routes from port to construction site (Assumed to include roads 5, 15, 80, 85, 95 and King Fahd Road). It should be noted that in accordance with Ministry of Transportation procedures there will be no transportation of oversized loads (i.e. wind turbines) at night.
Residents of local communities	Dumat Al Jandal and surrounding communities (including Al-Jouf University)
Seasonal and nomadic herders	Seasonal herder settlements
Recreational campers	Dumat Al Jandal and surrounding communities
Construction workers working at the Gypsum Quarry	1.5 km east of the Dumat Al Jandal Wind Energy Park

17.5 Impact Assessment

17.5.1 Construction Phase

The influx of a large number of construction workers will be the primary source of health impacts on the local community during construction. The degree of interaction with the local community will determine the significance of the impact. Potential sources of impacts during the construction phase include the following:

- Exposure to environmental factors (air quality, noise, water and contamination).
- Impacts of increased vehicle movement.
- Occupational health and safety of construction workers (including accidents and injuries, and mental health).
- Communicable and non-communicable diseases.

All construction workers would be subject to a comprehensive health screening process before commencing work, in order to identify any existing chronic conditions and/or occurrence of disease.

Potential impacts from construction of the Park were identified. These impacts are summarized in Table 17-4.

Table 17-4 : Summary Assessment of Health Impacts During Construction

ID	Receptor	Sensitivity	Impact	Impact characterization		Magnitude	Significance
HS01a	Construction workers	High	Risk to health, especially respiratory disorders and chronic respiratory diseases, from exposure to air pollution including dust, diesel particulates and NOx.	Effect:	Negative	Low	Moderate
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible and Irreversible (chronic conditions)		
HS01b	Local communities (including seasonal herders and recreational campers)	Moderate (due to distance to permanent settlements from the Park and transient nature of herders/campers)	Risk to health, especially respiratory disorders and chronic respiratory diseases, from exposure to air pollution including dust, diesel particulates and NOx.	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Certain		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Provincial		
				Permanence:	Reversible and Irreversible (chronic conditions)		
HS01c	Construction workers	High	Risk of hearing loss as a result of operation of construction plant.	Effect:	Negative	Low	Moderate
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Irreversible		
HS01d	Construction workers on surrounding projects	High	Risk to health, especially respiratory disorders and chronic respiratory diseases, from	Effect:	Negative	Low	Moderate
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous		

ID	Receptor	Sensitivity	Impact	Impact characterization		Magnitude	Significance
			exposure to air pollution including dust, diesel particulates and NOx, as well as Risk of hearing loss as a result of operation of construction plant.	Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible and Irreversible (chronic conditions)		
HS02	Construction workers	High	Risk to health from contaminated water supplies.	Effect:	Negative	Negligible	Negligible
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible		
HS03	Road Users	High	Road Traffic Accidents	Effect:	Negative	Moderate	High
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Irreversible		
HS04a	Construction workers	High	Working from height	Effect:	Negative	High	High
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)		
HS04b	Construction workers	High	Working in remote locations	Effect:	Negative	Low	Moderate
				Action:	Direct		

ID	Receptor	Sensitivity	Impact	Impact characterization		Magnitude	Significance
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible		
HS04c	Construction workers	High	Lifting operations	Effect:	Negative	Moderate	High
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)		
HS04d	Construction workers	High	Confined spaces working	Effect:	Negative	Moderate	High
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)		
HS04e	Construction workers	High	Workplace accidents and injuries, mental health	Effect:	Negative	Low	Moderate
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		

ID	Receptor	Sensitivity	Impact	Impact characterization		Magnitude	Significance
				Permanence:	Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)		
HS05a	Construction workers	High	Increased risk of contracting communicable or non-communicable diseases	Effect:	Negative	Low	Moderate
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short – Medium		
				Extent:	Local		
				Permanence:	Reversible (for most diseases) Irreversible (for some diseases)		
HS05b	Residents of local communities	High	Increased risk of contracting communicable or non-communicable diseases	Effect:	Negative	Low	Moderate
				Action:	Direct and Indirect		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short – Medium		
				Extent:	Regional		
				Permanence:	Reversible (for most diseases) Irreversible (for some diseases)		
HS06	Local communities (including seasonal herders and recreational campers)	High	Collision with construction plant and equipment / struck by objects	Effect:	Negative	Low	Moderate
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short – Medium		
				Extent:	Regional		
				Permanence:	Reversible (for most diseases) Irreversible (for some diseases)		

17.5.1.1 Construction Related Health Impacts from Air Quality and Noise (HS01)

The main environmental factors likely to occur during construction relate to emissions from the operation of mobile diesel plant (NOx and particulate matter (PM_{10} and $PM_{2.5}$), increases in traffic levels and an increase in dust particles.

Increased exposure to emissions from plant and vehicles can increase the sensitivity of individuals in vulnerable groups especially those diagnosed with chronic conditions such as asthma. However these impacts are not considered likely to occur for the following reasons:

- The site is located in an open area where emissions are likely to disperse rapidly, and background pollution levels are low.
- Construction workers will have undergone a comprehensive health screening process, meaning the likelihood of individuals being susceptible to these conditions would be low.
- The main permanent settlement, Dumat Al Jandal is located approximately 15 km south of the site and therefore risk of exposure to local communities is low.
- Seasonal herders and recreational campers would only be subject to limited, short term exposure, with both anticipated to avoid the surrounding area during the construction works.

Construction also has the potential to increase the levels of particulate matter in the form of dust. Increased exposure to dust can increase the incidence of non-communicable respiratory disorders and chronic respiratory diseases. These impacts are more likely to be seen in the workforce.

The increase in traffic movements and in particular those using the roads through Dumat Al Jandal (Road 80 and King Fahd Road) have the potential to adversely impact on the local air quality. King Fahd Road, the main access road to the Park passes through Dumat Al Jandal. The road is bordered by residential properties within Dumat Al Jandal, as well as areas for public recreation such as Ma'arid Castle and a public garden. Although volumes of traffic along access roads would increase during construction, these are not considered likely to be high enough to significantly affect air pollution levels over and above the existing traffic in the area. Therefore, community impacts are considered to be low and this is consistent with the impact assessment on air quality (Chapter 6).

Construction noise and vibration from on-site plant and machinery, can adversely affect peoples' quality of life. However given the distance to permanent settlements, the likelihood of noise-related health effects on the local community from the construction of the Park is considered to be low and this is consistent with the impact assessment on noise and vibration (Chapter 9).

The health effects of noise and vibration during the construction phase of the Park are more likely to be experienced by the construction workforce. These could include hearing loss caused by exposure to noise at work which continues to be a significant occupational disease, and hand arm vibration exposure. Factors that contribute to the health effects are: the noise level, level and type of vibration, and the length of exposure (e.g. daily or over a period of years). Exposure to noise is more common and it can take years for the health effects to be realized. Management of construction noise will follow Good International Industry Practice (GIIP) and will include consideration in the detailed design phases of changes in the construction process, and plant to minimize noise impacts, organization of the program and workforce to ensure rotation of staff, development of a comprehensive training program and provision of PPE where required, and implementation of monitoring and health surveillance measures during construction. The implementation of these measures will reduce the impact to low significance.

Construction related noise, vibration and dust can have adverse impacts on the local workforce working on projects nearby. A Gypsum Quarry which extracts and stores raw gypsum is located approximately 1.5 km east of the Park. However given the nature of the work carried out at the quarry, it is not anticipated that the construction works would give rise to impacts more adverse than already experienced. Therefore, a low impact is anticipated for the surrounding workforce.

17.5.1.2 Construction Related Health Impacts from Water (HS02)

Potable water will be supplied by a water tanker which will meet the required standards as defined by National Drinking Water Quality Standard for the Kingdom of Saudi Arabia (2012) and IFC Environmental Health, and Safety Guidelines for Water and Sanitation (2007), and therefore health risks to the workforce are considered negligible.

17.5.1.3 Increase in Construction Related Vehicle Accidents (HS03)

Traffic and transport details are presented in Chapter 13 – *Traffic & Transport Infrastructure*. This section identifies the potential impacts associated with physical movement of vehicles especially where they relate to Motor Vehicle Accidents (MVA). The GOSI Annual Statistical Report for 2015 states that 6 % of all workplace injuries/accidents are caused by MVAs at least half of these are in the construction industry.

During the construction of the Park, road traffic will increase due to the volume of material required to be brought to site via road. It is anticipated that tower components would be brought into the Kingdom of Saudi Arabia via seaport. This material will be transported along various highways and King Fahd Road, the latter of which is the primary access route to the development site.

Although the final route for transporting the turbines and other construction materials and equipment is yet to be confirmed, baseline traffic surveys have been undertaken on Road 80, the principal transportation route within the region, and King Fahd Road to the north of Dumat al Jandal town. The Level of Service (LOS) values for Road 80, calculated from traffic modelling, indicate freely moving traffic and therefore a road operating within capacity.

Baseline traffic surveys along King Fahd Road also indicate a very low volume of traffic both during the day and the evening, with only 80 vehicles recorded over a four hour period (2 hours in the morning and 2 hours in the afternoon).

During the construction of the Park, road traffic associated with the transportation of materials and wind turbine components to site will increase by approximately 14 vehicle movements per day. It has been assessed that for normal loads, there is capacity on the existing highway infrastructure to accommodate these additional vehicles without any significant reduction to road safety for other users and there is unlikely to be an increase in the incidence of MVAs.

The transportation of the wind turbine tower sections, blades and nacelles will require the use of oversized vehicles, which are estimated to travel in convoys of five vehicles simultaneously. The transportation of these unusual loads from the seaport to the construction site has the potential to increase the risk of MVAs.

A Logistics, Traffic and Transportation plan would be developed for the construction period of the Park. This plan would ensure that road closures and diversions are kept to a minimum, and wherever practicable and safe to do so, peak transportation hours must be avoided to reduce impacts on commuters and other road users. The plan would also include a commitment for quarterly road safety driver training and annual defensive driving training for direct employees and the supply chain.

The MOT "Exceptional Loads" 01-77 policy, dated 7-5-1432 (corresponding to 7th May 2011), outlines the permitting requirements for transporting exceptional loads and the specifications which constitute such a load. Requirements are laid out which must be fulfilled in order to obtain a permit. These include:

- Specifications of vehicles.
- Description of the load to be transported.
- The pre-submission time required to obtain a permit.

The standard also outlines commitments which must be met by the driver of the vehicle. These include:

- Commitment to follow the pre designated and approved route.

- Commitment to adhere to a pre designated and approved speed limit.

Permits, once issued, are valid for one trip, must be used during daytime hours only, and may not be used over weekends or public holidays. Police escorts will be utilized and active monitoring completed during the transportation of large components. Notwithstanding the MOT permitting requirements, the transportation of exceptional loads on local highway infrastructure has the potential to increase the risk of MVAs and the impact is assessed as being of high significance.

The location of the construction workers' camp has not yet been identified as part of the preliminary design but it will be assumed that they will be located within the boundary of the approved Land Use Permit (LUP). In the event workers are housed outside this, it is assumed the workforce will be brought to site via buses.

A Logistics, Traffic and Transportation Study will be undertaken by the IPP to ascertain the requirements for infrastructure upgrades and other works necessary to allow the safe passage of oversized and heavy specialist transportation vehicles. This would ensure all roads are well within capacity and are therefore considered capable of supporting the increased volume of traffic expected to arise as a result of the Park. Given the uncertainties around the Logistics, Traffic and Transportation Study, and types of vehicles, the precautionary approach has been adopted the impact is assessed as being of high significance.

17.5.1.4 Occupational Health and Safety of Construction Workers (HS04)

Many aspects related to occupational health (e.g. Motor Vehicle Accidents) have been assessed in the previous sections. This section will therefore consider general workforce accidents and injuries, diseases, and issues such as mental health and stress and specifically those listed in IFC EHS Guidelines for Wind Energy (2015)(i.e. working at height and protection from falling objects, working in remote locations and lifting operations). Although there are wadi channels within the developable area of the site, working over water is not considered to be an occupational health and safety risk. The national statistics for work force accidents, injuries and diseases are detailed in Section 17.3.4. In summary accidents and injuries in the construction industry, account for approximately half of all workforce injuries.

Working at Height

During the construction of the Park and the assembly of the wind turbines, construction works will frequently be undertaken at height. Falls from height are the largest cause of injuries and accidents in the Kingdom of Saudi Arabia (see Figure 17.3). The IFC EHS Guidelines for Wind Energy (2015), and the IFC EHS Guidelines for Electric Power Transmission and Distribution (2007) provide a comprehensive set of guidelines for the elimination of the risk, and for safe working procedures when working at height.

The main focus when managing working at height should be the prevention of a fall (IFC, 2015). However there are additional risks which must be fully considered and managed and these include falling objects (e.g. tools, components) and adverse weather conditions (high winds, extreme temperature, humidity). Exclusion zones should be established around construction activities when working at height is undertaken, and only approved personnel should be allowed to enter the exclusion zone. No unauthorized personnel or members of the public should be allowed to enter the exclusion zone.

Safe working practices for working at height will be implemented during the construction phase of the Park. However, even with mitigation in place, the risk of a potential fall exists with severe consequences possible. Therefore a high magnitude has been assigned. The impact is assessed as being of high significance.

Working in Remote Locations

The remote nature of the site, and the local geology (i.e. magnetized igneous rock) severely impacts on tele-communications and there is limited mobile phone coverage and satellite phones only work intermittently. The nearest accident and emergency hospital is the Doma General Hospital in Dumat al Jandal, approximately 15 km south of the site.

The IFC EHS Guidelines for Wind Energy (2015) and the Onshore Wind Health & Safety Guidelines (2015) set out a process for remote and lone working, which will be followed during construction. Guidance includes the use of thorough planning to ensure that the necessary resources are in place to support the task and any foreseeable incidents. Plans for managing accidents in remote locations will be set out in the Environmental Emergency Response Plan (EERP). With management plans in place, a moderate risk has been assigned.

Lifting Operations

Wind farm construction activities involve the lifting of large and heavy loads, such as tower sections, blades, nacelles. During construction, the wind turbine components will be transported to site in sections, where they will be assembled using complex pieces of lifting equipment. The IFC EHS Guidelines for Wind Energy (2015) and the Onshore Wind Health & Safety Guidelines (2015) produced by RenewableUK will be followed during heavy lifting operations.

Management will range from detailed calculations and hazard studies carried out in advance by a specialist team, to basic simple checks on the load and equipment, carried out by a competent person before executing the lift. These calculations and the selection of appropriate equipment will minimize the risk of heavy lifting equipment failing during lifting operations (e.g. a crane toppling over), and the risk of falling equipment and tools from height.

Exclusion zones should be established around construction activities during lifting operations, and only approved personnel should be allowed to enter the exclusion zone. No unauthorized personnel or members of the public should be allowed to enter the exclusion zone.

Based on the high sensitivity of the receptor, and the severity of potential impact, the impact is assessed as being of high significance. This also accounts for the fact that this will be one of the first utility scale wind energy power plants constructed in the Kingdom of Saudi Arabia and In-Kingdom contractors and equipment providers will have little experience of installing wind turbines.

Confined Spaces

As stated in the Onshore Wind Health & Safety Guidelines (2015) produced by RenewableUK, under the Confined Spaces Regulations 1997, “a ‘confined space’ must have both of the following defining features:

a. it must be a space which is substantially (though not always entirely) enclosed; and

b. one or more of the specified risks must be present or reasonably foreseeable”,

noting that “*A place not usually considered to be a confined space may become one if there is a change in the conditions inside or a change in the degree of enclosure or confinement, which may occur intermittently* ”.

The implication of this is that while some places will always be confined spaces, with permanent measures in place to restrict entry, other places may only require to be managed as confined spaces when certain operations are to be carried out, such as the use of solvents within a WTG nacelle; safe systems of work therefore need to identify when a confined space entry may occur (RenewableUK, 2015).

The typical hazards that may endanger people in confined spaces on wind farms, as reported by RenewableUK (2015), include:

- Loss of consciousness due to an increase in body temperature, as a result of working in a hot environment such as a transformer compartment;
- Loss of consciousness, or asphyxiation, due to the presence of hazardous substances, or lack of oxygen, in the atmosphere of a confined space:
- Hazardous substances may be present in the confined space prior to work commencing, or may arise as a result of work activities;
- Oxygen depletion can occur due to corrosion, work activities such as grinding, or workers’ breathing using up available oxygen in a confined space with inadequate air exchange;

- Inhaling an atmosphere that contains no oxygen can result in loss of consciousness within a few seconds;
- Inert gases such as nitrogen, which is often used in hydraulic accumulators on pitch systems in wind turbine generator hubs, can cause dangerous oxygen depletion if released; and,
- Injury arising from fire or explosion of substances.

During the assembly and installation of the wind turbines, construction workers may need to enter sections of the tower, nacelle, hub or blades to finish seams, grind, paint, etc. There is potential for these areas to constitute defined spaces depending on the substances present, the work to be carried out, and the level of ventilation.

Furthermore, substations, switch-rooms and locations within wind turbine generators that house gas-insulated switchgear containing Sulphur Hexafluoride (SF6) can present confined space hazards. In the event of any leakage, the SF6, which is heavier than air, will tend to collect in the lowest part of the structure, such as basements or cable trenches. While SF6 is non-toxic, repeated switching operations can lead to formation of decomposition products that are hazardous to health, even at extremely low concentrations (RenewableUK, 2015).

There is potential for fire and explosion while workers assemble the wind turbine generators, and this has the potential for catastrophic consequences for a worker whose only means of safe exit is to descend a foot ladder down the tower. In addition, the Nitrogen used in the accumulator, off-gassing of construction materials, poor ventilation can create a hazardous atmosphere (www.community.nfpa.org.news).

The IFC EHS Guidelines for Wind Energy (2015) and the Onshore Wind Health & Safety Guidelines (2015) produced by RenewableUK will be followed for managing the risk of construction activities in confined spaces. Based on the high sensitivity of the receptor, and the severity of potential impact, the impact is assessed as being of high significance.

Workplace accidents and injuries

In addition to the hazards which are specific to the construction of wind energy power plants, the construction workforce are at risk from more typical construction occupational health and safety hazards. These include the risk of trips and falls, collision with moving vehicles, plant and machinery and heat exhaustion. This latter hazard is particularly relevant to the Kingdom of Saudi Arabia where high summer temperatures and humidity are prevalent.

Workplace accidents and injuries can be reduced through the implementation of Good International Industry Practice (GIIP) in training, monitoring, Health, Safety and Environment (HSE) guidelines and practices. Injuries and accidents can be further reduced through the introduction of a program which addresses culture and behaviors on site. Furthermore, Corporate Policy and engagement with staff, suppliers and contractors will have a major impact on the success of any safety practices implemented on site.

The Park will be implemented using processes and procedures designed to international best practice and to be compliant with the IFC EHS *General Guidelines* (2007) and *Guidelines for Wind Energy* (2015). First aid services and medical facilities will be provided on site during the main construction period, and workers will have access to the new hospital in the Prince Mohammed Medical City in case of a serious incident. The *Guidelines for Wind Energy* refer to a set of guidelines produced by the British Wind Energy Association (BWEA) *BWEA Briefing Sheet: Offshore Wind* (2005). These guidelines are no longer available but there is equivalent guidance prepared by RenewableUK: *Onshore Wind Health & Safety Guidelines* (2015) which provide a comprehensive set of guidelines for safe working procedures during construction, operation and maintenance of onshore wind turbines. These guidelines will be followed throughout the lifecycle of the Park.

An EERP will be developed as part of ESIA (see Chapter 21) which will detail the response to severe injuries/accidents. A comprehensive safety management program will be developed for the site in order to prevent the EERP having to be implemented. The safety management programme will look at how to prevent slips and trips around the site and other safety factors.

Mental health and stress

Mental health and stress is also an important consideration for any workforce. The accommodation camp will be designed to provide a high standard of accommodation with recreational facilities, and access to on-site health care staff, all of which will contribute to a reduction in stress and improved mental health. Working hours, holidays, pay, grievance mechanisms etc., will also be implemented according to National Labor laws, ensuring the employment conditions are suitable and do not contribute to an increase in stress.

Audits of the worker accommodation should be undertaken in accordance with the IFC and the European Bank for Reconstruction and Development (EBRD) guidance note: *Worker's Accommodation: Process and Standards* (IFC 2009). This document includes checklists with the level of required facilities, layout and expectations for the provision of all workers accommodation both during construction and operation. Audits should also be undertaken to ensure workers receive the benefits they are contractually obliged to receive, including timely receipt of salaries.

17.5.1.5 Communicable and Non-Communicable Diseases (HS05)

The baseline assessment suggests that the cases of many communicable diseases within the Al-Jouf region are relatively low and below the national average (see Table 17-2), especially for cases of malaria which are primarily brought into the area through migration of workers. Transmission of such diseases amongst the construction workers themselves and transmission between the construction workers and the local community must both be considered.

The exact location, layout, and facilities will be determined in the next phases, however the construction workers are likely to be housed in shared accommodation with communal toilet and shower facilities. The close living quarters and communal kitchens could increase the spread of infectious diseases that may be present. The accommodation camps during construction will be designed to National Labor Law and in line with the guidance published in the IFC Workers Accommodation: Processes and Standards (IFC 2009). In addition, a comprehensive health screening program for workers will be developed in compliance with the Kingdom of Saudi Arabia regulations.

Interaction of construction workers within the local community will be reduced due to the establishment of the accommodation camps assumed to be located within the LUP boundary, approximately 15 km from the northern outskirts of Dumat Al Jandal. Worker needs and facilities will be provided within the accommodation areas, and this also reduces the potential interaction with the local community. The influx of approximately 360 workers is not likely to have a significant impact within Dumat Al Jandal, which had a population of 32,613 (General Authority for Statistics, 2010) according to the 2010 Census.

The transmission of communicable diseases, from workers associated with the Park, may reach families and the community at large, however the scale of this risk from the Park is likely to be low compared with the scale of inward migration from other development in and around Dumat Al Jandal and Sakaka. The risk of transmission of communicable diseases is therefore expected to be higher among the workers themselves.

The incidence rate of a variety of commonly occurring infectious ailments and diseases, such as chickenpox, hepatitis, and diarrhea may increase. However the implementation of a comprehensive health screening program, compliance and implementation of international HSE standards and the World Bank EHS guidelines, provision of a medical facility with fully trained staff, and the introduction of a comprehensive information/training program will reduce the significance of the potential impact, which is considered to be moderate. The provision of catering facilities for the workforce, which will ensure the supply of food is in line with health regulations, should prevent an increase in the incidence of brucellosis in the local area.

17.5.1.6 Collision with construction plant and equipment / struck by objects (HS06)

During construction, it has been assumed that security fencing will only be installed around the perimeter of the construction camp, including worker accommodation, and around the perimeter of the sub-stations. The remainder of the construction site will remain open. This assumption is based on discussions with the project proponent who have confirmed that it is impracticable to fence the full development boundary of the Park.

In the absence of a physical exclusion, it will be possible for the local community to access the developable area of the Park. This includes seasonal herders and recreational campers. Although this access will be unauthorized, the local community will be at risk of hazards associated with the construction phase of the Park. This includes work at height and the risk of falling objects, heavy lifting operations and the movement of construction traffic within the developable area of the Park.

Exclusion zones should be established around construction activities during hazardous operations and no unauthorized personnel or members of the public should be allowed to enter the exclusion zone. The IPP should fully engage with the local community prior to the commencement of construction activities to ensure the local community are made aware of the risks, and collective measures are implemented to avoid and minimize these risks.

Based on the high sensitivity of the receptor, and the severity of potential impact, the impact is assessed as being of moderate significance.

17.5.2 Operation Phase

The potential impacts considered once the Park is operational are:

- Blade throw from a wind turbine (with associated risk of injury);
- Motor vehicle accidents from occasional security and maintenance visits and transportation of exceptional loads;
- Accidents, slips and trips from occasional security and maintenance visits;
- Interference with aviation;
- Electromagnetic interference and radiation;
- Trespassing and climbing of wind turbines;
- Working at Height;
- Heavy Lifting Operations; and,
- Confined Spaces Working.

The risks associated with working at height, heavy lifting and confined spaces working are similar to those assessed for the construction phase and are not assessed independently for the operation phase. The impacts predicted during the operation phase of the Park, over and above those identified during the construction phase, are summarized in Table 17-5.

Table 17-5 : Summary Assessment of Health Impacts During Operation

ID	Receptor	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
HS07a	Local community residents	High	Blade throw from wind turbines	Effect:	Negative	Negligible	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Rare		
				Duration:	Short		
				Extent:	Local		

ID	Receptor	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
				Permanence:	Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)		
HS07b	Construction workers on surrounding projects	High	Blade throw from wind turbines	Effect:	Negative	Negligible	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Rare		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)		
HS07c	Local herders and recreational campers	High	Blade throw from wind turbines	Effect:	Negative	Negligible	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Rare		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)		
HS07d	Road users	High	Blade throw from wind turbines	Effect:	Negative	Negligible	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Rare		
				Duration:	Short		
				Extent:	Local		

ID	Receptor	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
				Permanence:	Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)		
HS07e	Security and maintenance crews on temporary site visits	High	Blade throw from wind turbines	Effect:	Negative	Negligible	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Rare		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)		
HS08	Road users	High	Motor vehicle accidents (with associated risks of injuries, fatalities and effects on mental wellbeing)	Effect:	Negative	Moderate	High
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Rare		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Irreversible		
HS09	Security and maintenance crews on temporary site visits	High	Occupational health and safety during maintenance and inspection of turbines.	Effect:	Negative	High	High
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Local		

ID	Receptor	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
				Permanence:	Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)		
HS010	Aviation receptors	Low	Direct collision between wind turbines and aviation or indirect through alteration of flight paths.	Effect:	Negative	Negligible	Negligible
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous (daily basis)		
				Duration:	Medium		
				Extent:	Provincial		
				Permanence:	Reversible		
HS11	Electromagnetic interference and radiation	Moderate	Wind turbine electromagnetic interference with telecommunication systems e.g. microwave, television and radio.	Effect:	Negative	Negligible	Negligible
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous (daily basis)		
				Duration:	Medium		
				Extent:	Provincial		
				Permanence:	Reversible		
HS12a	Local individuals	High	Accidents as a result of trespassing and/or climbing of wind turbines	Effect:	Negative	Negligible	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Medium		
				Extent:	Local		
				Permanence:	Reversible		
HS12b	Infrastructure within Park	Moderate	Damage to infrastructure within the Wind	Effect:	Negative	Negligible	Negligible
				Action:	Direct		

ID	Receptor	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
			Farm as a result of trespassing and/or climbing of wind turbines	Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Medium		
				Extent:	Local		
				Permanence:	Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)		

17.5.2.1 Blade throw from a wind turbine (HS07)

A failure of a wind turbine rotor blade can result in a blade becoming detached and falling. This represents a safety risk to local communities, nearby workers on surrounding projects, local herders, recreational campers and occasional maintenance staff. In line with UK Health and Safety Executive research Study and Development of a Methodology for the Estimation of the Risk and Harm to Persons from Wind Turbines (2013), the risk of blade throw is deemed to be negligible.

The project proponent has specified set-back distances of 1000 m from the inhabited properties for the location of wind turbines. Given the remote nature of the site, the risk to surrounding inhabited properties is negligible. Furthermore, Dumat Al Jandal and the nearby Gypsum Quarry are located sufficient distances away from the Park. Therefore the risk of blade throw to local communities and nearby workers is anticipated to be negligible

The project proponent has also stated a set-back distance of 70 m from the site boundary for the location of wind turbines. A 200 m set back distance has been specified from main primary and secondary roads. This set back distance is deemed to be sufficient to reduce risk to road users to low.

During operation, local herders and recreational campers will be able to gain unauthorized access the Park. However the wind turbines will be subject to continuous monitoring and regular maintenance such that the likelihood of blade throw is assessed as unlikely and rare.

A negligible risk of blade throw has been deemed in accordance with the UK Health and Safety Executive research Study and Development of a Methodology for the Estimation of the Risk and Harm to Persons from Wind Turbines (2013). This is also supported by California Wind Energy Collaborative (2005) which states that setbacks are usually a multiple of the total turbine height, from tower base to upper extreme point of the rotor; and generally the setbacks can vary from 1.25 to 3 times the overall machine height. In the case of turbines of 225m, the set-back would be a maximum of 675m.

It is assumed that the following measures will be implemented:

- Minimize the probability of a blade failure by selecting wind turbines that have been subject to independent design verification/certification (e.g., IEC 61400-1), and surveillance of manufacturing quality.
- Ensure that lightning protection systems are properly installed and maintained.
- Carry out periodic blade inspections and repair any defects that could affect blade integrity.
- Equip wind turbines with vibration sensors that can react to any imbalance in the rotor blades and shut down the turbine if necessary.

17.5.2.2 Motor vehicle accidents from occasional security and maintenance visits (HS08)

The Dumat Al Jandal Wind Energy Park will generate wind energy using automated infrastructure. There will be no full-time staff located at the Park, with security and maintenance of the Park carried out through occasional site visits. For this reason, the magnitude of impact on road safety for the local community is anticipated to be negligible for routine operations. The impact is therefore assessed as being of low significance.

During non-routine operations there might be a requirement to transport replacement wind turbine components to the Park. The transportation of the wind turbine tower sections, blades and nacelles will require the use of oversized vehicles, which are estimated to travel in convoys of five vehicles simultaneously. The transportation of these unusual loads from the seaport to the construction site has the potential to increase the risk of MVAs.

A Logistics, Traffic and Transportation plan would be developed for turbine component replacements and maintenance. This plan would ensure that road closures and diversions are kept to a minimum, and wherever practicable and safe to do so, peak transportation hours must be avoided to reduce impacts on commuters and other road users. Given the uncertainties around the Logistics, Traffic and Transportation plan the precautionary approach has been adopted the impact is assessed as being of high significance.

17.5.2.3 Health and safety from occasional security and maintenance visits (HS09)

Security and maintenance personnel carrying out temporary site visits will follow safe operating procedures for wind farm sites set out in Onshore Wind Health & Safety Guidelines (2015). Maintenance will include climbing of the turbines to carry out detailed inspections and maintenance.

Hazards associated with inspections and maintenance include working at height, confined spaces working and working in remote locations. During the operation phase of the Park there will be no other site presence other than the security and maintenance team, and there will be no medical or first aid facilities. The IPP must develop comprehensive safety management plans for the operation phase of the Park to ensure the effective management of risk in accordance with IFC EHS Guidelines for Wind Energy (2015), the IFC EHS Guidelines for Electric Power Transmission and Distribution (2007) and the IFC General EHS Guidelines (2007).

This includes a plan for safe working in a remote location where communications are hampered by the local topography and geology. In case of an accident or emergency, the site team must be able to readily communicate with the emergency services for effective rescue. The IPP must fully engage and consult with the emergency services in Al Jouf Province during the development of emergency response plans.

Based on the high sensitivity of the receptor, and the severity of potential impact, the impact is assessed as being of high significance.

17.5.2.4 Interference with aviation (HS10)

Wind farms located in the flight paths of nearby airports can have an impact on aviation either directly through potential collision or indirectly by altering the flight paths of planes. IFC EHS *Guidelines for Wind Energy* (2015) recommend the implementation of the following prevention and control measures to try and avoid these impacts:

- Consult with the relevant aviation authorities before installation, in accordance with air traffic safety regulations.
- When feasible, avoid siting wind energy facilities close to airports and within known low-flying areas or flight paths.
- Use anti-collision lighting and marking systems on towers and/or blades and consult with the relevant aviation authorities to determine appropriate lighting and marking requirements in line with national standards. In the absence of national standards, refer to good practice guidance[11].

[11] International Civil Aviation Organization (ICAO) 2012; CAA 2013; American Wind Energy Association (AWEA) 2008; CanWEA 2011.

Al Jouf International Airport is located approximately 25 km south-east of the site. A single radar has been identified at this location, it is assumed that this radar is used to track incoming and outgoing aircraft. The height of the antenna is presently unknown.

An obstacle evaluation was requested and undertaken by GACA. GACA has confirmed that they have no objection to the proposed development provided a 25km safeguarding distance is maintained to Al Jouf Airport. As such, there is likely to be minimal to no negative impact to the operation of this radar.

Although the Dumat al Jandal Wind Energy Park lies beyond the aerodrome safeguarding limits for Al Jouf, GACA has stipulated that aviation obstructing lighting is installed and that the wind turbines are painted to increase their visual conspicuity.

The Dumat al Jandal wind energy Park falls outside of the 6km safeguarding zone requested by the Ministry of Defence. On this basis, no significant impacts are predicted. However, it is recommended that further consultations are held with the Ministry of Defence and further analysis is undertaken to determine that the Park will not adversely impact on the radar systems of the military base. Using the EUROCONTROL guideline, and based on its distance to the airport, Dumat al Jandal will fall within the Zone 3 or 4, should the radar at Al Jouf International Airport be a Primary Surveillance Radar (PSR). This will mean that a simple assessment would be required, should it be established that the proposed Park is within maximum instrumented range and in radar line of sight.

The standard 1 km setback distance has been used and this has shown no significant impact on telecommunication facilities. However, it is recommended that further analysis is undertaken to determine the Fresnel zones of associated microwave paths and ensure the location of individual wind turbines in the Park do not compromise telecommunication signals (point-to-point).

17.5.2.5 Electromagnetic interference and radiation (HS11)

Wind turbines have the potential to cause electromagnetic interference with telecommunication systems e.g. radio. The interference from wind turbines could be caused by path obstruction, shadowing, reflection, scattering or re-radiation.

With regards to telecommunication interference, both broadcast type systems and point-to-point systems can be affected. In order to prevent this type of interference, the IFC EHS *Guidelines for Wind Energy* (2015) recommend the following mitigation measures:

- Modify placement of wind turbines to avoid direct physical interference of point-to-point communication systems; consultation with relevant operators can assist in establishing the location of telecommunication links and relevant buffers to be applied in order to minimize impacts.
- Install a directional antenna.
- Modify the existing aerial.
- Install an amplifier to boost the signal.

Interference and radiation could be particularly disruptive to the emergency response plans set up for the site. For example if there was interference with radio connections when calling for emergency help from remote locations. With the recommended prevention and control measures noted above however, a negligible risk is anticipated.

17.5.2.6 Trespassing and climbing of wind turbines (HS12)

Wind farm facilities can attract unauthorized climbing of the turbines and substation. In line with recommendations set out in IFC EHS *Guidelines for Wind Energy* (2015), 50 m of fencing will be constructed around each turbine to prevent unauthorized access. The implementation of security fencing, as well as the location of the Park approximately 15 km north of Dumat Al Jandal, would limit the likelihood of trespassing to negligible.

Typically within the Kingdom of Saudi Arabia, there are no known problems with damage, theft or vandalism of infrastructure. The IPP must ensure that appropriate measures are taken in the detailed design to reduce the hazards to members of the public, and signage must be installed where there is a risk of electrocution etc.

The impact is assessed as being of negligible significance.

17.5.3 Decommissioning Phase

The impacts associated with the decommissioning of the Park with regard to health and safety, are expected to be similar to those expected to occur during the construction and operation phase. No new impacts are predicted.

17.6 Mitigation

This section details the mitigation which should be included as part of the detailed design, construction and operational stages to reduce potential impacts further and/or realize further benefits.

A hierarchical approach to mitigation development has been adopted to manage impacts identified for the construction, operational and decommissioning phases of the Park.

- Avoid – Alter the design of the project such that an effect is avoided;
- Reduce – Alter the design of the project so that an effect is reduced;
- Abate – Abate the effect either at source or at the receptor;
- Repair – Restore or reinstate a feature after effects have occurred (i.e. temporary construction impacts); and,
- Compensate – Compensate for permanent loss or damage of a feature.

Implementation of mitigation measures will be required during construction, operation and decommissioning of the Park to minimize potential negative impacts of the activities on health and safety aspects. The mitigation measures comprise a combination of, management procedures and further assessments to be undertaken at detailed design and are described in the subsequent sections.

17.6.1 Construction Phase

Construction phase impacts will be mitigated through the application of measures set out in Table 17-6.

Table 17-6 : Construction Impact and Mitigation Summary

ID	Potential Significance	Mitigation Measures	Residual Significance
HS01a, HS01c & HS01d	Moderate	A dust management plan (DMP) is recommended as outlined in chapter 6 *Air Quality and Meteorology*. Ensure all staff are equipped with PPE appropriate to the task and that workers are subject to regular medical and fitness checks.	Low
HS02	Negligible	No additional measures over and above adherence to quality control measures for tanked water supplies have been identified.	Negligible
HS03	High	Training and awareness on issues such as defensive driving will be provided to the workforce. Contractor to develop and employ a traffic management plan in order to ensure road traffic accidents are minimized and avoided. The IPP should implement a Permit to Work scheme, whereby workers and operators can provide documented evidence that they are fully competent to undertake a specific task or activity, or operate an item of equipment. In this instance, drivers of vehicles carrying exceptional loads must demonstrate that they are competent to do so.	Moderate

ID	Potential Significance	Mitigation Measures	Residual Significance
HS04a	High	The IPP should implement a Permit to Work scheme, whereby workers and operators can provide documented evidence that they are fully competent to undertake a specific task or activity, or operate an item of equipment. In this instance, workers must be able to demonstrate that they are qualified and competent to work at height. The Permit to Work scheme will also require the development of a fully considered plan which demonstrates how the activity will be undertaken safely, including any specific studies or calculations that need to be performed and a full emergency response plan in case of an incident. The Permit to Work scheme should also ensure workers at height are subject to regular medical and fitness checks.	Moderate
HS04b	Moderate	Early engagement with local service providers to assess the capacity of the region to absorb any potential issues should be undertaken, and this will inform the design and staffing of the facilities to ensure local services are not adversely affected. This consultation should include all emergency services to ensure agreement is reached on the most effective mechanisms to deal with any major incident.	Low
HS04e	Moderate	Worker accommodation should be developed in accordance with: • IFC EHS *General Guidelines* (2007) which detail specific requirements for Occupational and Community Health, Safety and Welfare. • IFC Performance Standard 2 (2012) – *Labor and Working Conditions*. • IFC Performance Standard 2 (2010) - *Handbook for Labor and Working Conditions*. IFC and European Bank for Reconstruction and Development (EBRD) guidance note: *Worker's Accommodation: Process and Standards* (IFC 2009).	Low
HS04c	High	The IPP should implement a Permit to Work scheme, whereby workers and operators can provide documented evidence that they are fully competent to undertake a specific task or activity, or operate an item of equipment. In this instance, operators must be able to demonstrate that they are qualified and competent to operate heavy lifting equipment. The Permit to Work scheme will also require the development of a fully considered plan which demonstrates how the activity will be undertaken safely, including any specific studies or calculations that need to be performed and a full emergency response plan in case of an incident. The Permit to Work scheme should also ensure operators are subject to regular medical and fitness checks.	Moderate
HS04d	High	The IPP should implement a Permit to Work scheme, whereby workers and operators can provide documented evidence that they are fully competent to undertake a specific task or activity, or operate an item of equipment. In this instance, workers must be able to demonstrate that they are qualified and competent to work in confined spaces. The Permit to Work scheme will also require the development of	Moderate

ID	Potential Significance	Mitigation Measures	Residual Significance
		a fully considered plan which demonstrates how the activity will be undertaken safely, including any specific studies or calculations that need to be performed and a full emergency response plan in case of an incident. The Permit to Work scheme should also ensure workers are subject to regular medical and fitness checks.	
HS05a	Moderate	In addition to the health screening and measures in place for establishing worker accommodation, training and awareness raising on issues such as infection control and health promoting activities will help mitigate the effect further.	Low
HS05b	Moderate	No further measures have been identified other than the health screening and measures in place for establishing worker accommodation.	Low

17.6.2 Operation Phase

Operation phase impacts will be mitigated through the application of measures set out in Table 17-7. Mitigation for operational impacts for working at height, confined spaces, remote locations and heavy lifting are covered under construction phase mitigation.

Table 17-7 Operation Impact and Mitigation Summary

ID	Potential Significance	Mitigation Measures	Residual Significance
HS08	High	Training and awareness on issues such as defensive driving will be provided to the workforce. Contractor to develop and employ a traffic management plan in order to ensure road traffic accidents are minimized and avoided. The IPP should implement a Permit to Work scheme, whereby workers and operators can provide documented evidence that they are fully competent to undertake a specific task or activity, or operate an item of equipment. In this instance, drivers of vehicles carrying exceptional loads must demonstrate that they are competent to do so.	Moderate
HS09	High	Standard good operational practice will be utilized on all site visits in line with Onshore Wind Health & Safety Guidelines (2015). The IPP should implement a Permit to Work scheme, whereby workers and operators can provide documented evidence that they are fully competent to undertake a specific task or activity, or operate an item of equipment. In this instance, workers must be able to demonstrate that they are qualified and competent to work at height, confined spaces and remote locations. The Permit to Work scheme will also require the development of a fully considered plan which demonstrates how the activity will be undertaken safely, including any specific studies or calculations that need to be performed and a full emergency response plan in case of an incident. The Permit to Work scheme should also ensure workers at height are subject to regular medical and fitness checks.	Moderate

17.6.3 Decommissioning Phase

The mitigation measures required and recommended for decommissioning are the same as those set out for construction and operation phase impacts (refer to Table 17-6 and Table 17-7).

17.7 Conclusion

This chapter has assessed health and safety aspects of the construction, operation and decommissioning of the Dumat Al Jandal Wind Energy Park. Due to the relatively isolated location of the Park and the type of construction activities to be undertaken, the main potential hazards relate to the risk of transmission of communicable diseases between workers, construction related accidents and injuries (i.e. working at height, heavy lifting, remote working, confined spaces working) and the increased risk of traffic accidents during the transportation of exceptional loads.

Even with mitigation there are a number of residual risks of moderate significance. These risks recognize the unique hazards to the development of wind energy power plants and have considered that this will be one of the first developments of its type within the Kingdom of Saudi Arabia. As such, the construction workforce within the Kingdom will not be skilled in the assembly and installation and ongoing maintenance of wind energy power plants.

It is recommended that the IPP develops a Permit to Work system for the development and operation of the Park. A Permit to Work system is a management system that is used to ensure that work is done safely and efficiently and establishes procedures to request, review, authorize, document and most importantly, deconflict tasks to be carried out by frontline workers. This is particularly important for high risk construction and maintenance operations (e.g. working at height, heavy lifting, confined spaces working, remote working).

The Permit to Work system must account for the unique environment of the Kingdom of Saudi Arabia, including extreme temperatures and humidity, in-Kingdom workforce attitudes and behaviors towards safety and the preservation of life, and religious practices (e.g. fasting during the month of Ramadan).

In addition to the health screening of workers for communicable disease, it is recommended that workers who perform high risk activities (i.e. working at height, confined spaces working) and operators of specialist equipment (e.g. heavy lifting equipment, vehicles carrying exceptional loads) are subject to regular medical and fitness checks.

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18. Sustainable Development

18.1 Introduction

As a part of the Environmental and Social Impact Assessment (ESIA), it is important that the sustainability of the proposed development is evaluated against a range of recognized criteria, giving consideration to economic, social and ecological processes as well as the optimization of trade-offs across the three systems. The assessment of sustainability provided in this section has been undertaken by analyzing how elements of sustainable development were integrated into the ESIA process and into the design and planning of the Park itself. The sustainable development assessment is designed to ensure that the entire lifecycle of the Park is taken into consideration.

18.2 Sustainable Development Context

18.1.1 Sustainable Development as a Policy Context

The modern concept of sustainable development emerged from a series of meetings and reports during the 1970s and 1980s. The most significant step in recognition of the concept of sustainable development came in 1987 when the UN-sponsored Brundtland Commission drafted *'Our Common Future'*, which detailed widespread concerns about poverty and the environment in different regions of the world. The report stated that whilst economic development cannot stop, it must change course to ensure that it fits within the ecological limits of the planet. The Brundtland Commission defined sustainable development as: *"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* (UNWCED, 1987).

The Brundtland report also noted that; *"Major unintended changes are occurring in the atmosphere, in soils, in waters, among plants and animals. Nature is bountiful but it is also fragile and finely balanced. There are thresholds that cannot be crossed without endangering the basic integrity of the system. Today we are close to many of those thresholds."*

The Commission identified a number of "common challenges" facing the earth:

- population and human resources;
- food security, species and ecosystems;
- energy;
- industrial development; and,
- urbanization.

At the time of the Brundtland Commission, water sustainability and climate change were also identified as related/contributory issues, however these issues have since been acknowledged as serious global problems in their own right. The Commission went on to outline a series of "strategic imperatives," or "critical objectives," inherent in their concept of sustainable development. In response to the Commission's report, the need to respond to the concept of sustainable development gained momentum in organizations around the world. In 1992 the UN Conference on Environment and Development (also known as the 'Earth Summit') was held in Rio de Janeiro and attended by 172 of the world's governments. The Earth Summit achieved a broad political consensus around the concept of sustainability as articulated in the adopted 27 principles Rio Declaration, which provided a framework for governments to improve environmental and economic conditions around the world. The Summit also initiated Agenda 21, which introduced a comprehensive program of action for global action in all areas of sustainable development. The establishment of the Millennium Development Goals (MDGs) at the Millennium Summit in 2000 continued the global movement towards the elimination of poverty and achievement of sustained development.

Since its inception four decades ago, the adoption of sustainable development principles has become factored into decision-making at all levels in government, public and private sector organizations throughout the world.

18.3 Sustainable Development in Saudi Arabia

Sustainable development is inherent in the principles of Islam, which hold that the protection, conservation and development of the environment and its natural resources are a mandatory duty to which every Muslim should be committed". In December 1994, the Kingdom of Saudi Arabia's Council of Ministers approved the Kingdom's National Agenda 21 implementation plan to achieve sustainable development goals, formalizing this inherent concept. The 9th National Development Plan (NDP) (2010-2014) has the overall theme of sustaining national development and supports an overarching goal of having the Kingdom of Saudi Arabia become: "A developed, thriving and prosperous economy, built on sustainable foundations. It will extend rewarding work opportunities to all citizens, will have a high-quality education and training system, provide excellent healthcare for all, and offer all necessary services to ensure welfare of all citizens; all while safeguarding social and religious values and preserving national heritage."

The modern concept of sustainable development (environmental, social and economic factors) is also enshrined within the legislation and policies of the General Administration for Meteorology and Environment, Recognition of sustainable development is also evident in the policies, procedures and activities of other organizations within the Kingdom, such as the Ministry for Energy, Industry and Mineral Resources, and Saudi Aramco.

The Kingdom's focus on diversification of industry, and expansion of the employment opportunities, is in keeping with the concept of sustainable development, and has increased focus on improving efficiency of resource use and taking advantage of green economy concepts.

Most recently, the government of the Kingdom of Saudi Arabia have produced their vision for the future of the country within the document 'Vision 2030'. Within this document, is a section entitled '*Achieving Environmental Sustainability',* which lays out the foundations of the vision for the Kingdom of Saudi Arabia as it moves towards a more sustainable future.

The document draws on similar themes to the Brundtland report and the National Agenda 21. The document states that *"By preserving our environment and natural resources, we fulfill our Islamic, human and moral duties. Preservation is also our responsibility to future generations and essential to the quality of our daily lives. We will seek to safeguard our environment by increasing the efficiency of waste management, establishing comprehensive recycling projects, reducing all types of pollution and fighting desertification. We will also promote the optimal use of our water resources by reducing consumption and utilizing treated and renewable water. We will direct our efforts towards protecting and rehabilitating our beautiful beaches, natural reserves and islands, making them open to everyone. We will seek the participation of the private sector and government funds in these efforts."* Vision 2030 also includes a section related to Renewable Energy which puts forward the target for 9.5GW of renewable energy by the year 2023.

18.4 IFC and Sustainable Development

The International Finance Corporation (IFC) considers multiple dimensions of sustainability in its approach to risk management with regards to decision-making on its investments. This is articulated through the Sustainability Framework, an integral part of the IFC's strategic commitment to sustainable development. The Sustainability Framework consists of the Policy on Environmental and Social Sustainability (IFC, 2012), which defines the IFC's commitments to environmental and social sustainability, and the Performance Standards, which define a client's responsibilities for managing the environmental and social risks associated with their project (IFC, 2012). This applies to all clients whose projects go through the IFC's initial credit review process, and therefore the Sustainability Framework applies to the Dumat Al Jandal Wind Energy Park.

18.5 Assessing Sustainable Development

Although renewable energy projects such as the Dumat Al Jandal Wind Energy Park, by their nature represent a shift from unsustainable, to more sustainable means of energy production, there exists an opportunity, through sustainable assessment to manage and mitigate the risks associated with the construction and decommissioning of the projects, to ensure that the entire project lifecycle is carried out in the most sustainable way possible.

There is no single methodology for assessing the incorporation of sustainable development principles by a project. In the case of the Dumat Al Jandal Wind Energy Park, it is important that the assessment incorporates consideration of the sustainable development requirements of the Parks interested parties, namely the Lending Institution (World Bank/International Finance Corporation) and the General Administration for Meteorology and Environment (GAME), as well as the three core fundamentals of sustainable development (consideration of environmental, social and economic factors).

The assessment considers the incorporation of sustainable development in the various sections of the ESIA and the incorporation of sustainable development into the Park itself. The sustainability assessment assists in determining the extent to which sustainable development has been considered and incorporated into the ESIA process, which then in turn enables a more thorough assessment of sustainable development for the Park.

18.6 Sustainable Development Assessment Methodology

The ESIA has been prepared to address the environmental, social and economic requirements of the World Bank and IFC performance standards. Environmental, social and economic requirements as stipulated by the Kingdom of Saudi Arabia and GAME, as well as those of Saudi Aramco have been given due consideration in the preparation of the ESIA.

Table 2-1 within Chapter 2 - Policy, Legal and Regulatory Framework, demonstrates how the ESIA addresses the performance standards, and thus the integration of sustainable development principles. Therefore the sustainable development assessment shall focus on the extent to which the project may be considered sustainable. The sustainability of a development can be judged in terms of the extent to which it meets the needs of the present, without impinging on the needs of future generations. The principles of intra-generational and inter-generational equity can be used to evaluate this on the basis of the temporal and spatial extent of the impacts. Intra-generational equity is the principle of equity between different groups of people alive today. Similarly to inter-generational equity, intra-generational equity implies that consumption and production in one community should not undermine the ecological, social, and economic basis for other communities to maintain or improve their quality of life (International Institute for Sustainable Development (IISD), 1997). Examples of intra-generational equity include identifying impacts that may affect different social groups and ensuring suitable mitigation exists and giving consideration to the comments made by members of the public with regards to the project and ESIA.

Inter-generational equity is the principle of equity between people alive today and future generations. The implication is that unsustainable production and consumption by today's society will degrade the ecological, social, and economic basis for tomorrow's society, whereas sustainability involves ensuring that future generations will have the means to achieve a quality of life equal to or better than today's (IISD, 1997). Examples of intergenerational equity include identifying ecosystems that may be affected by the development and assessing the risk of irreversible damage occurring to them and ensuring that an integrated assessment approach has been applied by the ESIA, weighing environmental, social and economic factors against one another.

Consideration is also given to global impacts for example climate change, loss of biodiversity, the depletion of natural resources and human rights.

The methodology employed for the sustainable development assessment of the Park will consider the residual impacts identified within the ESIA of the Dumat Al Jandal Wind Energy Park using the criteria of timescale and extent. The principles of intra-generational equity and inter-generational equity will be used to take account of the duration associated with each significant impact identified. The likely extent of the impact, in terms of geographical area, is also considered. Together these factors provide a means to evaluate the sustainability of the project.

The matrix presented as Table 18-1, which has been developed using the principles of a risk assessment, and will be used to assess the sustainable development implications of the significant environmental, social and economic impacts of the Park.

Table 18-1: Criteria for Sustainable Development Assessment

TIMESCALE	**Extended**				

	Long				
	Medium				
	Short				
		Local	**Regional**	**National**	**International**
		EXTENT			

The definitions provided in Table 18-2 apply to each of the criteria for the sustainable development assessment.

Table 18-2: Definitions for Sustainable Development Assessment

Extent	**Local**	Within a 2 km radius of the immediate Project area
	Provincial	Outside the local area, but within 200 km
	National	Within the borders of the Kingdom of Saudi Arabia
	International	Outside the borders of the Kingdom of Saudi Arabia
Timescale	**Short**	Less than one year
	Medium	More than one year, but less than or equal to the operational lifetime of the project (25 years for the Dumat Al Jandal Wind Energy Park)
	Long	Greater than the lifetime of the project, but less than or equal to 100 years
	Extended	Greater than 100 years

All residual environmental, social and economic impacts, regardless of significance, identified by the ESIA will be assessed against the sustainable development assessment criteria in order to give an indication of the sustainability of the project and plotted into the matrix illustrated in Table 18-3.

Those impacts which are grouped towards the bottom left of the table (i.e. shorter-term, localized impacts) can be considered to have a reduced impact on sustainable development (i.e. the project is more sustainable), whereas those residual impacts grouped towards the top right of the table (i.e. longer-term, widespread impacts) can be considered to have a greater impact on sustainable development (i.e. the project is less sustainable).

Positive impacts identified by the ESIA will also be plotted to identify the positive impacts on sustainable development generated by the Park. However, in the case of positive impacts, those grouped towards the top right can be considered more sustainable and those grouped towards the bottom left can be considered less sustainable.

18.7 Sustainable Development Assessment of the Dumat Al Jandal Wind Energy Park

As discussed in Chapter 3 *Consideration of Alternatives*, the alternatives to the project considered environmental, social and economic factors.

This ESIA and its associated studies, such as the migratory bird surveys and noise study, have been performed during the design phase. These studies evaluate the effects of the Park from an environmental, social and economic perspective. Predictions of potential significant impacts on both social and environmental components help to establish appropriate mitigation and enhancement measures at an early stage of the project. Through the consideration of environmental and social aspects in the various studies undertaken, the Park is integrating the principles of sustainable development.

Throughout the ESIA, at the end of each chapter, measures required to prevent, minimize or mitigate the identified impacts have been suggested. Implementation of the proposed measures is anticipated to minimize negative impacts and enhance positive impacts in order to maximize the sustainability of the project. The residual impacts identified throughout the ESIA have been classified in terms of their temporal and spatial extent. These are presented in the following tables, by reference to the impact Identification Code (ID Code), which is consistent with the coding presented in each respective section of the ESIA. Colors used to indicate the significance of each residual impact are included within the key below each table.

Table 18-3 and High, Medium, Low

Table 18-4 show the residual negative and positive effects of the Park classified according to their timescale and extent.

Table 18-3: Sustainability Assessment: Residual Negative Effects

TIMESCALE	Extended				
	Long	HH02,NO05,NO06,TB21	SE03		
	Medium	SG02,SG03,SG04, ,LA04,LA05,LA06,LA07,LA08,LA09,LA10,LA11,LA12,SE09, ,WM01,WM02,WM03,WM06,HS12a,HS12b	TT01, TT03,SE08,HS05b,HS06,HS10,HS11, UT04		
	Short	AQ01,SG01,SG05,SG06, SG07,SG08,SG09,HH01, HH03,HH04,NO01,NO02, NO03,NO04 ,LA01, ,LA02,LA03,TB02,TB03,TB04,TB05,TB06,TB07,TB08,TB09,TB10,TT02,CH01SE05,SE06,SE11,SE12, UT01,UT02,WM04,WM05, HS01a,HS01c,HS01d,HS02,HS03,HS04a,HS04b,HS04c,HS04d,HS04e,HS05a,HS07a,HS07b,HS07c,HS07d,HS07e,HS08,HS09,	TB11,TB12,TB13,TB16,TB17 ,TB18,TB19, TB22,SE01,SE02,SE04,SE07 ,SE10,HS01b	TB01	AQ02
		Local	Regional	National	International
		EXTENT			

High, Medium, Low

Table 18-4: Sustainability Assessment: Residual Positive Effects

TIMESCALE	Extended				
	Long				AQ03
	Medium			UT03	
	Short				

	Local	Regional	National	International

The spatial and temporal classification of negative residual impacts identifies that the majority of residual negative impacts are localized to the area surrounding the development site, and are of low significance. The duration of these local impacts extend from the short term to medium term. This indicates that these impacts are anticipated to cease on completion of the Project life. The majority of negative residual impacts from the Project affect environmental factors associated with the modern concept of sustainable development.

18.8 The Dumat Al Jandal Wind Energy Park and Stakeholder Engagement

One of the three core principles of sustainable development focuses on the social elements of projects. The purpose of stakeholder engagement is to understand and manage social impacts of projects, and is key. Chapter 14 *Socio-Economic Aspects*, and the stakeholder engagement plan addresses the social element of sustainability in more detail. Stakeholder engagement for the Park has commenced, and the ongoing implementation will further support the Project in understanding and responding to the social dimension.

18.9 Conclusion and Recommendations

In terms of long term environmental sustainability, the Dumat Al Jandal Wind Energy Park represents a shift in traditional energy generation in the Kingdom of Saudi Arabia, away from fossil fueled power generation, towards the use of sustainable technology. This is a significant positive impact for the sustainability of the nation as a whole.

While there are negative impacts associated with the construction and decommissioning of the Park, these are far outweighed by the long term sustainability benefit of shifting the energy generation mix of the Kingdom of Saudi Arabia away from fossil fuels, towards more sustainable forms of energy generation.

18.10 References

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19. Cumulative Impact Assessment

19.1 Introduction

As part of the ESIA process, it is important to consider cumulative impacts. Cumulative Impacts represent the contribution that the Park plays towards the overall trend of environmental degradation or improvement as assessed alongside other existing and planned projects within the surrounding area. The objective of this chapter is to assess these impacts through consideration of the impacts of the Park as identified in the preceding chapters, and the impacts of other known projects taking place in the vicinity of the Park which could affect the same social and environmental resources and receptors and can therefore be expected to have a combined effect.

The cumulative impact assessment responds to the requirements of the International Finance Corporation (IFC) Performance Standard 1 Assessment and Management of Environmental and Social Risks and Impacts, which requires that environmental and social risks and impacts are identified in the context of a project's area of influence, including *"cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted."*

The IFC provides the following definition for cumulative impacts:

"Cumulative impacts are limited to those impacts generally recognized as important on the basis of scientific concerns and/or concerns from Affected Communities. Examples of cumulative impacts include: incremental contribution of gaseous emissions to an air shed; reduction of water flows in a watershed due to multiple withdrawals; increases in sediment loads to a watershed; interference with migratory routes or wildlife movement; or more traffic congestion and accidents due to increases in vehicular traffic on community roadway".

19.2 Existing and Future Proposed Projects

19.2.1 Stakeholder Consultation

Typically, proposed projects in the vicinity of a development would be confirmed during stakeholder engagement and consultation. An initial round of stakeholder consultation with Government Ministries has been undertaken during a workshop in Riyadh held on 22nd May 2017. During this workshop planned and future projects in the vicinity of the Park were established. However stakeholder consultation will be an ongoing process, and will be continued by the IPP during the development of the Park. The understanding of proposed nearby projects is expected to develop as stakeholder consultation progresses.

19.2.2 Expansion of Overhead Power Lines

The SEC is currently installing a new 380 kV overhead power line, to the east of the Park which connects to the Al Jouf Power Plant. The Park will connect into these power lines through a substation. Although the location of this substation is currently unconfirmed, it is expected to be located to the south-west of the Park. As per the requirements of Performance Standard 1, for the purposes of assessment, this substation will be considered in the context of the Park. Performance Standard 1 states that assessment should include:

"Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable"

19.2.3 Expansion of Quarry

The licensed boundary of the gypsum quarry is unknown, and at this stage it is unknown whether plans exist to expand the existing quarry further towards the site boundary. There are no other known plans for development within the boundary of the development site or in close proximity to its boundary.

19.2.4 Sakaka Solar Energy Park

The Sakaka Solar Energy Park is due to be constructed approximately 25 km south-east of the development site boundary. This development is currently in the permitting phase is expected to begin construction in 2017 and will be in operation for 20 years.

19.2.5 Midyan Wind Energy Park

The proposed Midyan Wind Energy Park will consist of 160 turbines and will be located on the Red Sea coast, approximately 130 km west of the town of Tabuk in Tabuk Province. Construction of the proposed development is expected to begin in 2017 and the development will be operational for 20 years. Although this Project is geographically remote to the Dumat al Jandal Wind Energy Park, it will contribute towards the national objective of moving towards a low carbon energy.

19.2.6 MODON Industrial City for Women

MODON strives to benefit from the experiences of Saudi women, especially in the field of industry to eliminate unemployment and employ these energies either as workers in the field or investors and business managers. As a result, the Council of the Ministers decided to allocate lands in major cities to empower women to work within residential areas and appointed MODON to establish these cities. MODON began implementing them according to the international standards and integrated infrastructure along with services and designs that meet the needs of the Saudi Woman and provide all the means to help them work in the fields of transportation, nursing homes and institutions of training (www.modon.gov.sa).

An industrial city for women is proposed approximately 20 km south-east of the development site boundary. It covers a total area of 3 million square meters. It is distinguished for its strategic location to agricultural regions and the Jordanian border, in addition to the availability of vital services such as highway infrastructure, power supplies and others in the city. No further details are known at the time of writing the ESIA, including the proposed schedule for development.

19.3 Cumulative Impact with Other Projects

19.3.1 Meteorology, Climate & Air Quality

Chapter 6 *Meteorology, Climate & Air Quality,* identifies a moderate benefit associated with the offset of greenhouse gasses resulting from the operation of the Park. Although there would be a temporary reduction in air quality due to the use of diesel powered generators and the general operation of plant during the construction phase of the Park, this is offset by the net benefit associated with reduction in greenhouse gasses occurring as a result of operation of the Park.

Due to the potential offset of diesel power generation at local fossil fuel power plants created by the Park, the ambient air quality headroom (and associated capacity for future development) is increased by the Park. There are low levels of greenhouse gas emissions associated with the operation of the Park, and these are offset by the generation of renewable energy.

As one of the pioneering wind energy projects within the Kingdom of Saudi Arabia, the Park has the potential to contribute towards a precedent for future development in the Kingdom of Saudi Arabia and begin a cumulative trend towards cleaner energy generation.

Impact CI01 – Moderate Significance

Table 19-1: Cumulative Air Quality Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI01	Air Quality	High	Reduction in overall greenhouse gas emissions at a national level.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Positive Direct Likely Continuous Long National Permanent	Moderate	Moderate Positive

19.3.2 Soils & Geology

Chapter 7 *Soils and Geology* identifies the minimal impact which the Park is expected to have upon the soils and geology of the local area. There is no identified current trend of impact upon soils and geology in the local area arising from existing development, and the soils within the developable area of the Park are already impoverished and there is negligible economic benefit derived from the existing resource. Due to the reversible nature of impacts associated with the Park, the cumulative impact upon soils & geology is considered to be of low significance.

Impact CI02 - Low Significance.

Table 19-2: Cumulative Soils & Geology Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI02	Local Soils	Moderate	The Park will be entirely deconstructed and removed upon decommissioning. and all soil will be returned to its baseline condition.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Continuous Medium Local Temporary	Low	Low

19.3.3 Hydrology & Hydrogeology

Chapter 8 *Hydrology & Hydrogeology* identifies the predicted impacts upon local hydrology and hydrogeology expected to arise as a result of the Park. Impacts are expected to be minimal due to the fact that the layout of the Park has been designed in such a way that turbines will be located outside the wadi flow paths, sinkholes and catchments, as per the recommendations of the flood risk assessment.

The current trend is towards the exploitation of aquifers within the Kingdom of Saudi Arabia. The Park does not draw on, nor is it expected to impact upon any groundwater resources, and therefore does not contribute towards the trend of exploitation.

The trend towards further development within the Kingdom of Saudi Arabia and particularly within the area surrounding the development site, where center pivot irrigation forms an important element of the local economy, will increase pressure on existing water resources. The construction and operation of the Dumat al Jandal Wind Energy Park will contribute towards this trend, however, the impact is not expected to be major, and will be most significant during the construction phase of the park, which is temporary. Operation of the Park will require a very small amount of water and is not expected to contribute in a meaningful way to the continued increases in pressure on local water production facilities. No groundwater abstraction is to be carried out in relation to the development of the Park, contribution to cumulative trends would be through the utilization of existing supplies.

Surface water flow at the development site and in the surrounding area is infrequent, limited to flash flooding over the plateau, which drains through the minor wadi flow paths, and from the site via the wadi channels located on the edges of the development site. The design of the Park is established in such a way that impact upon these flows is minor, and therefore is not considered to contribute towards the cumulative trend of alteration of surface water flows within the development site, or the surrounding area.

Cumulative impacts associated with hydrology and hydrogeology are therefore considered to be of low significance.

Impact CI03 - Low Significance

Table 19-3: Cumulative Hydrology & Hydrogeology Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI03	Local Soils	Moderate	Contribution to the current trend of impacts upon hydrology & hydrogeology	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Local Temporary	Low	Low

19.3.4 Noise & Vibration

The baseline noise levels within the area surrounding the development site are currently low, at an average daytime value of 45 dba, which is compared with 55 dba free field noise limits for daytime scenarios laid out in the IFC EHS guidelines. This average value considers three receptors, two located on the edge of Dumat Al Jandal, and one located immediately adjacent to the development site. It is of note that of these three, the receptor located immediately adjacent to the development site had a significantly lower value, of 26 dba compared to 51 and 58 for the other two locations.

"The IFC EHS Guidelines for Wind states that '*If the preliminary model suggests that turbine noise at all sensitive receptors is likely to be below an LA90 of 35 decibels (dB0 (A) at a wind speed of 10 meters/second (m/s) at 10m height during day and night times, then this preliminary modelling is likely to be sufficient to assess noise impact; otherwise it is recommended that more detailed modeling be carried out, which may include background ambient noise measurements.*"

The Guidelines also state that:

"*All modeling should take account of the cumulative noise from all wind energy facilities in the vicinity having the potential to increase noise levels*"

The assessment in Chapter 9 *Noise and Vibration* has established that the operation of the Park could result in a noise level of above 35dba at the nearest sensitive receptors. Therefore, it is recommended that further consideration is given to the design during the next phase of development by the IPP.

In terms of cumulative effects, the impact of the Park is limited to the area immediately surrounding it, and therefore it is not anticipated that the Park would contribute to the broader impact of increased noise in the area surrounding the development site. There are no other know developments in proximity to the Park or sensitive receptors which have the capacity to increase ambient noise levels.

It is however, recognized that the Park could set a precedent for increased noise levels within the area surrounding the development site and therefore, a precautionary significance of high has been applied pending further noise modelling.

Impact CI04 – Moderate Significance.

Table 19-4: Cumulative Noise & Vibration Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI04	Receptors in the surroundings of the development site.	High	Increase of baseline noise level at receptors close to development site.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Continuous Medium Local Temporary	Moderate	High

19.3.5 Landscape & Visual

Low impacts were assessed in relation to the Park. The Park would represent the introduction of infrastructure into an environment which already contains vertical infrastructure, particularly within short range views and is therefore not considered 'un-spoilt'. The landscape in which the Park would be located is not designated as being of any great landscape value.

Although the Park could be seen as introducing the first major infrastructure into the long range views of the plateau present within the local area, the scale of the view is very large, and it is considered that it would therefore be able to accommodate this change without significant negative impact.,

Shadow flicker has been assessed and concluded to be no issue.

Based on the above, cumulative impacts associated with Landscape and Visual are considered to be of low significance.

Impact CI05 - Low Significance

Table 19-5: Cumulative Landscape & Visual Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI05	Local Landscape	Moderate	The Park is expected to make a minimal contribution to the current trend of impacts upon landscape receptors.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Local Temporary	Low	Low

19.3.6 Terrestrial Biodiversity

The majority of impacts on ecological receptors during the construction, operation and decommissioning of the Park are predicted to be low or negligible. Therefore there are no cumulative impacts predicted at this stage of the assessment.

The assessment of impact on migratory birds has yet to be undertaken, and will be completed following the autumn migration surveys. However, there is no other project of this type or scale in the region that has the potential to impact on migratory or resident bird species and so no cumulative impacts are predicted.

Impact CI06 - Low Significance

Table 19-6: Cumulative Terrestrial Biodiversity Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI06	Ecological receptors	Moderate	Impacts on migratory birds	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short National Temporary	Low	Low

19.3.7 Archaeology & Cultural Heritage

Chapter 12 *Archaeology & Cultural Heritage* identifies no predicted impacts related to the Park upon known and unknown assets within the area surrounding the development site. There are no sensitive receptors within the development site, and therefore no significant cumulative impacts are expected to arise from the Park.

The implementation of a properly managed 'chance find' procedure for the discovery of assets during the development of the Park could result in a positive impact upon the understanding of archaeology and cultural heritage within the development site, and within the Kingdom of Saudi Arabia as a whole and the world.

The cumulative impacts associated with archaeology and cultural heritage are considered to be of low significance.

Impact CI07 - Low Significance

Table 19-7: Cumulative Archaeology & Cultural Heritage Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI07	Receptors in the surroundings of the development site.	Moderate	The Park is expected to have no impact upon known assets within the surrounding area and could potentially unearth new assets.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Positive Direct Unlikely Infrequent Short International Temporary	Low	Low

19.3.8 Traffic & Transportation Infrastructure

Chapter 13 *Traffic & Transport Infrastructure* identifies the increases in traffic movements associated with the Park. The construction phase of the Park is expected to result in increased traffic on the roads surrounding the development site. This is due to the abnormal requirements of wind turbine components during transportation. There is a potential for significant disruption and delays as a result of required road closures and diversions associated with the construction of the Park. The IPP will be responsible for the preparation of a traffic management plan which will consider the routes of least disruption to be taken during transportation of turbines. Until this plan is understood, the impact remains at moderate significance.

During the operational phase of the Park, the impact upon traffic and transport infrastructure is expected to be minimal, as it is restricted to occasional deliveries and a small number of workers travelling to and from the development site.

The current trend within the surrounding area is towards an increased volume of traffic making use of local roads. The Park will contribute to this during the construction phase; however it will not impact significantly upon this during the operation phase.

There is a potential for cumulative impacts upon local traffic and transportation infrastructure where projects are scheduled to be constructed simultaneously. The Midyan Wind Energy Park is due to be constructed during a similar timeframe to the Dumat Al Jandal Wind Energy Park, and will make use of the same port infrastructure (Dubha, Jubail and Aqaba Ports). Due to the requirement to utilize similar routes to and from the ports, particularly Road 80, which runs from the port at Jubail, across the Kingdom of Saudi Arabia, the potential impact, should these projects be constructed simultaneously, is significant. As the intended routes to site are not yet confirmed, and due to the high magnitude of the potential impact, the significance associated with this impact is assessed as being high.

Furthermore, in the local context the Sakaka Solar Energy Park and MODON Industrial City for Women will contribute to greater volumes of construction traffic on the local highway infrastructure, in particular Road 80. As the schedules for these projects are yet to be confirmed, a precautionary approach has been taken. Due to the high magnitude of the potential impact, the significance associated with this impact is assessed as being high.

No exceptional loads are anticipated for the construction of the Sakaka Solar Energy Park or MODON Industrial City for Women. However exceptional loads are predicted for the Midyan and Dumat Al Jandal Wind Energy Parks. In combination, the transportation of exceptional loads simultaneously could result in a trend towards reduced road safety for other road users.

Stakeholder consultation should be undertaken to confirm the program for other projects proposed within the local area, and to co-ordinate the import of wind turbines into the Kingdom of Saudi Arabia.

Impact CI08 – High Significance.

Table 19-8: Cumulative Traffic and Transportation Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI08	Highway capacity and road users	High	There will be increased traffic and disruption during the construction phase of the Park; and the transportation of exceptional loads increases the risk of MVAs. .	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Frequent Short National Temporary	High	High

19.3.9 Socio-Economic Aspects

Chapter 14 *Socio-economic Aspects* identifies the socio-economic impacts and benefits of the Park. Adverse impacts of moderate significance are predicted, associated with the reduced access to land, loss of livelihood and changes in land use. However with the implementation of mitigation, including further stakeholder engagement and consultation to be undertaken by the IPP, and the development of Livelihood Restoration Plan in accordance with IFC Performance Standard 5, residual impacts of low significance are predicted.

The value of the developable area of the Park to the local community is not considered to be significance, and the current land-uses can continue following construction of the Park. In combination with other projects, there are no significant cumulative impacts predicted within the region.

Impact CI09 - Low Significance

Table 19-9: Cumulative Socio-Economic Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI09	Local population	Moderate	Increased employment opportunities.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Positive Direct Likely Continuous Medium Local Temporary	Low	Low

19.3.10 Utilities & Infrastructure Usage

Chapter 15 *Utilities & Infrastructure Usage* identifies the minimal impacts upon local utilities and infrastructure which are expected to arise as a result of the Park.

The current trend towards increased development in the local area suggests that local utility supplies will be subject to greater usage over coming years, although it is noted that capacity is expected to increase relative to demand.

There is sufficient headroom to accommodate the Park as the impacts expected to arise as a result of the Park are assessed as low significance, and therefore the contribution these make to the cumulative trend, are also assessed as low significance. The Park is expected to make a positive contribution to the headroom of local power generation infrastructure, thereby reducing the pressure on these resources. As a result of this, the Park is assessed as having a medium positive cumulative impact upon power generation resources in the local area.

Impact CI10 - Medium Significance

Table 19-10: Cumulative Utility and Infrastructure Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI10	Local Utilities & Infrastructure	Low	Reduced strain upon existing capacity of local infrastructure	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Positive Direct Certain Frequent Medium National Temporary	Moderate	Positive Moderate

19.3.11 Waste Management

Chapter 16 *Waste Management* identifies potential waste expected to be generated by the Park during construction, operation and decommissioning.

The main impacts on waste management infrastructure are expected to occur during the construction and decommissioning phases of the Park and will be associated with the use of hazardous and non-hazardous construction materials. Limited waste is expected to be generated during the operational phase of the Park.

At this stage of the development, the capacity and availability of existing waste management infrastructure remains uncertain, subject to further stakeholder consultation by the IPP. The residual quantities of waste to be sent to landfill are as yet undetermined, and as the capacity of the waste management facilities and landfill sites is currently unknown, there is a potential for exceedance of operational capacity, in particular during the decommissioning phase where project related impacts are assessed as moderate significance. Further consultation by the IPP with the local stakeholders will confirm the operational capacity of waste management infrastructure with the aim of reducing the residual impact to low.

The current trend within the Kingdom of Saudi Arabia is towards increased waste generation, the Park will contribute to this during the temporary construction and decommissioning phases. In particular during the decommissioning phase of the Project there will be significant quantities of waste generated, including decommissioned turbines. This will potentially coincide with the decommissioning of the Sakaka Solar Energy Park. Until further consultation has been held with waste management service providers and a better understanding has been developed on the potential waste management requirements of other projects in the Province, a precautionary impact of moderate significance are predicted.

Impact CI11 - Moderate Significance

Table 19-11: Cumulative Waste Management Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI11	Local waste management infrastructure	Moderate	Increased volume of waste during the construction phase of the Park.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Local Temporary	Moderate	Moderate

19.3.12 Health & Safety Aspects

Chapter 17 Health and Safety Aspects identifies potential health and safety impacts expected to be generated by the Park during construction, operation and decommissioning. A range of high and moderate impacts are predicted prior to the implementation of mitigation, ranging from occupational health and safety hazards to the transportation of exceptional loads and the risk of Motor Vehicle Accidents (MVAs) and increased incidence of communicable disease following immigration . With mitigation, there are several impacts of moderate residual significance (i.e. transportation of exceptional loads and the risk of MVAs, occupational health and safety hazards unique to wind energy power plants such as working at height, confined spaces working and working in remote locations).

There has been a general upwards trend in MVAs in the Kingdom of Saudi Arabia and the transportation of exceptional loads during this Project, in combination with increased construction traffic associated with other developments in the Province has the potential to contribute towards this national trend.

Work related injuries decreased steadily between 2005 and 2013, but show a fairly substantial upturn in 2014. A total of 69,241 cases of work related injuries were reported in the Annual Statistical Report for 2014, of which only 5.4 % occurred to Saudi nationals. The majority of injuries (51.3 %) occurred within the construction industry, with a further 18.7 % within the building services trade and 16.5 % within transformative industries. The remaining industries (trade, mining and quarrying, social services, agriculture and fishing, electricity and water, financing and real estate) each comprised less than 5 % of reported injuries. The leading causes of injuries were falls, collisions and rubbing or abrasion (see Figure 17.3). The significant majority of injuries recorded were recovered without disability, however 10.9 % were recovered with disability and 1.5 % resulted in death.

Although the general trend over recent years has been a reduction in workplace accidents, 2014 showed an increase and it is possible that as the Kingdom of Saudi Arabia steps up its efforts to diversify the economy and move away from the oil and gas sectors, this recent trend could yet continue on an upward trend. The high risk areas of work associated with the construction and operation of the Park have the potential to contribute towards this trend.

Impact CI12 - High Significance

Table 19-12: Cumulative Health and Safety Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI12	Local communities and construction / maintenance and inspection workers	High	Increased incidence of MVAs / increase incidence of workplace accidents.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Local Reversible (if injury is recoverable) Irreversible (if injury is permanent or results in death)	High	High

19.4 Mitigation and Recommendations

Impact CI04 – Moderate Significance

Noise emissions from the Park shall inform the final design stages of the Park. This may include further noise modelling prediction and analysis of design options, which will inform the final scheme design so as to optimize both the siting and selection of turbines. Following this, a detailed assessment of operational noise impacts associated with the proposed wind farm site shall be undertaken once the turbines have been selected and once the number and location of each turbine has been finalized within the final scheme design. The assessment shall follow the principles and approach outlined with the IFC EHS Guidelines: Wind Energy. Detailed noise modelling shall be adopted, and the assessment approach should be consistent with that detailed in ETSU-R-97 and IoA GPG. Such an assessment approach would require additional baseline background sound level monitoring at the worst-affected noise sensitive receptors identified within this assessment in a range of wind conditions and with concurrent wind measurements. This assessment shall be presented as an addendum to the ESIA.

If significant effects are still predicted then mitigation in the form of glazing at the sensitive receptors, compensation for nuisance, and lastly relocation, shall be reviewed. This assessment should also take into consideration the potential for cumulative noise generation when the Park is sited amongst other development proposed in the local area.

ID	Potential Significance	Mitigation Measures	Residual Significance
CI04	High	Implementation of further studies regarding the impact of the Park – modification of the design to reduce noise impact from specific turbines, assessment with regard to future proposed development.	Low

Impact CI08 – High Significance

The cumulative impact associated with the simultaneous construction of multiple wind energy parks is predominantly related to the overloading of infrastructure at the ports anticipated to be utilized for the receipt of turbine components from abroad. At present it is not understood how this will be managed at a logistical level.

During the next phase of development, a traffic impact assessment will be compiled by the IPP as part of the Environmental Management and Monitoring Plan. This plan will include an assessment of the impacts upon ports and local roads anticipated as a result of the simultaneous delivery of turbine components and construction of wind energy parks.

Furthermore, it is recommended that consultation is carried out between the proponents of the various projects, in order to coordinate the phasing and delivery of turbine components and the construction of the various projects.

Ongoing monitoring of traffic will take place in order to minimize impacts associated with it.

ID	Potential Significance	Mitigation Measures	Residual Significance
CI04	High	Assessment of traffic impacts in relation to simultaneous construction of multiple wind energy parks and preparation of appropriate traffic management plan as part of EMMP	Moderate

Impact CI11 – High Significance

Potentially cumulative adverse impacts are predicted on waste management facilities, particularly during the decommissioning of the Dumat al Jandal Wind Energy Park, and potentially the Sakaka Solar Energy Park. Until further consultation has been held with the waste management service providers and the local Amana by the IPP, there is potentially a significant impact on the capacity of existing infrastructure which can only be mitigated through a fully integrated approach to waste management with other projects in the region, and the full implementation of the waste management hierarchy which includes avoidance of waste generation, and optimizing the re-use and recycling of waste materials.

ID	Potential Significance	Mitigation Measures	Residual Significance
CI11	Moderate	IPP to develop a decommissioning site waste management plan in consultation with local stakeholders, waste management contractors and equipment suppliers (i.e. suppliers of wind turbines). The IPP should also work with the local service providers and Government Ministries to optimize the re-use and recycling of waste materials within the Kingdom of Saudi Arabia and reduce the volume of material sent to landfill.	Low

Impact CI12 – High Significance

To mitigate against the potential for cumulative health and safety impacts on local communities and the construction workforce within the Kingdom of Saudi Arabia, it is recommended that the National Renewable Energy Program (NREP) implements a Permit to Work system. This system would ensure that the NREP does not contribute towards any further upward trends in MVAs or workplace accidents. This Permit to Work system should be promoted at the national level with the relevant Government Ministries for wider acceptance and implantation.

ID	Potential Significance	Mitigation Measures	Residual Significance
CI12	High	It is recommended that the IPP develops a Permit to Work system for the development and operation of the power plants developed under the National Renewable energy Program (NREP). A Permit to Work system is a management system that is used to ensure that work is done safely and efficiently and establishes procedures to request, review, authorize, document and most importantly, deconflict tasks to be carried out by frontline workers. This is particularly important for high	Moderate

ID	Potential Significance	Mitigation Measures	Residual Significance
		risk construction and maintenance operations (e.g. working at height, heavy lifting, confined spaces working, remote working). The NREP should promote the benefits of this system and encourage its implementation across the construction sector thereby contributing towards a general downwards trend in workplace accidents and reduced MVAs associated with exceptional loads.	

19.5 Conclusions

Following the implementation of mitigation, there are some residual cumulative impacts of moderate significance associated with traffic and transportation and health and safety aspects. There remains some uncertainty and there is a requirement to complete further stakeholder consultation and engagement, following which it might be possible to further reduce these impacts to low significance. However, the precautionary principle has been adopted and at this stage of the design, impacts are assessed as moderate for traffic and transportation and health and safety aspects.

There are numerous identified positive cumulative trends associated with the development of the Park, particularly related to the precedent which it is hoped the Park will set in terms of the progression from fossil fuels to renewable energy sources and the change this will represent for the Kingdom of Saudi Arabia’s energy generation mix.

20. Environmental Monitoring and Management Plan

20.1 Introduction

20.1.1.1 Purpose of this chapter

This chapter provides the outline and draft structure of the Environmental Management and Monitoring Plan (EMMP) that will be developed over the life of the Dumat Al Jandal Energy Park (the Park). The Independent Power Producer (IPP) will develop a detailed EMMP for the construction phase for approval by the project proponent (i.e. Renewable Energy Project Development Office of the Ministry of Energy Industry and Mineral Resources (MEIM)) prior to implementation, and the EMMP for the operation phase of the Park will be developed during detail design.

20.1.1.2 Purpose of the EMMP

The purpose of the EMMP is to help facilitate and manage the identified environmental aspects and impacts of the proposed development as it progresses from detailed design through to the construction, commissioning, operation and decommissioning phases.

The EMMP translates the findings and recommendations of the ESIA, into a set of procedures and plans for implementation on the ground, and identifies those parties responsible for implementing them.

Guidance and instruction provided by the EMMP aims to reduce the risk of adverse effects to both the environment and those involved in the Park.

The EMMP is consistent with the current design, which will be further developed over the life of the project. It has therefore been prepared as a dynamic document that will be reviewed and amended to a final EMMP for operation of the Park.

20.1.1.3 Scope of the EMMP

The scope of the EMMP includes the following:

- Identify environmental management responsibilities and assign individuals to them;
- Identify statutory obligations;
- Develop incident management and corrective action procedures;
- Identify complaint handling responsibilities;
- Provide an outline of environmental action plans, and staffing and training recommendations;
- Provide auditing requirements; and,
- Identify and provide guidance on training programs.

20.1.1.4 Objectives of the EMMP

The primary objectives of this EMMP are to provide an environmental management manual for use by management and staff involved in the Project and to provide information to regulatory authorities regarding the environmental management practices that will be implemented throughout the life of the project.

The EMMP has the following main objectives:

- To provide a framework that facilitates Project compliance with environmental policy commitments and regulation through documentation of the mitigation measures that will be applied during the construction, commissioning and operational phases of the Project;
- To define the environmental action plan required to implement the various mitigation measures and recommendations outlined in the ESIA;
- To identify the monitoring programs that will be implemented to verify and manage predicted effects and confirm performance of mitigation measures;
- To describe resources that will be made available to implement the recommendations of the EIA including staffing and training requirements; and,
- To manage environmental risk through training, audit and review.

20.1.1.5 Regulations and Guidance

The EMMP will be developed, in accordance with the following regulations and guidance:

- PME General Environmental Regulations and Rules for Implementation (2001);
- PME Supplementary Environmental Standards (2012);
- KSA Labor Law (2005);
- World Bank Environmental Assessment Sourcebook Update: Volume 3 – guidelines for environmental assessment of energy and industry projects;
- IFC (International Finance Corporation). January 2012. Performance Standards 1 – 8;
- IFC (2007), Environmental, Health and Safety (EHS) Guidelines, General EHS Guidelines;
- IFC (2015), Environmental, Health and Safety Guidelines Wind Energy;
- IFC (2007), Environmental, Health and Safety Guidelines for Electrical Power Transmission and Distribution;
- IFC (2007), Environmental, Health and Safety Guidelines for Water and Sanitation; and,
- A legislative overview is provided in Table 20-1.

20.1.1.6 Relationship to other plans

The EMMP shall be used in conjunction with actions plans, such as the Waste Management Plan, which address specific project-related risks and impacts and will guide the implementation of the Park so that it is undertaken in a safe, cost effective, planned and environmentally responsible manner.

The IPP will be required to draw on the requirements of the EMMP and incorporate these into the Construction Environmental Management Plan (CEMP).

The EMMP seeks to integrate with existing documents including corporate and site specific management policies wherever possible.

20.2 Implementation of the Plan

20.2.1 Statutory Environmental Regulations

The Dumat Al Jandal Energy Park Environmental Manager and Construction Environmental Manager shall ensure compliance with all applicable Regulations and Guidelines, and shall ensure that new regulations are monitored and implemented as applicable and required.

The Park will be located within a Saudi Aramco reservation. The environmental permitting jurisdiction for this development therefore falls under the Ministry of Energy, Industry and Mineral Resources (MEIM). Renewable energy developments in the Kingdom are required to achieve compliance with national regulations and standards, including the Presidency of Meteorology and Environment (PME) Appendix 2.1 General Environmental Regulations and Rules of Implementation (GERRI) (2001) and the Royal Commission Environmental Regulations (RCER) 2015, where applicable.

In addition, and where relevant, the Park must adhere to the requirements of the World Bank Group, specifically the IFC's World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines). These guidelines provide technical reference documents with general and industry-specific examples of good international industry practice, and are used by the IFC as a technical source of information during project appraisal activities. The following guidelines are of relevance to the Park:

- General Environmental, Health, and Safety Guidelines, April 30 2007;
- Environmental, Health and Safety Guidelines Wind Energy, 2015;
- Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution; and,
- IFC (2007), Environmental, Health and Safety Guidelines for Water and Sanitation.

The IFC requires that when host country regulations differ from the levels and measures presented in the IFC Environmental, Health, and Safety Guidelines or World Health Organization standards, projects are expected to achieve whichever is more stringent.

In the event that the GAME does not specify a standard relevant to a project site, then the project shall use for reference other recognized regulations as a basis for technical justification in the following order:

- The U.S. Environmental Protection Agency (US EPA);
- U.S. State environmental rules and guidelines;
- European Union (EU) members environmental rules and guidelines; and,
- Other internationally recognized and accepted regulatory bodies.

A summary of legislation and Good International Industry Practice relevant to this EMMP is included in Table 20-1.

20.2.2 Roles and Responsibilities

The Contractor(s), in consultation with the Client, is required to define the roles of the Construction Team, with specific reference to roles and responsibilities as they relate to the environmental management of their specific tasks. Responsibilities of the Construction Manager are shown in sections 20.2.2.1 to 20.2.2.3.

20.2.2.1 The Client (Renewable Energy Project Development Office of the MEIM)

The Client's role (inclusive of a Project Management Team) includes but is not limited to the following:

- Outlining the environmental requirements for the project pursuant with company policy, standards and procedures, and providing copies of these;
- Advising of any changes to their environmental requirements especially those that may influence planning and permitting activities;
- Specifying any relevant site specific targets, impacts or mitigation measures (over and above PME requirements known to the Construction Team) to be incorporated into permit applications;

- Providing information to enable the Project to meet its environmental objectives;
- Reviewing and approving deliverables and subsequently submitting these to the relevant authorities as appropriate, e.g. compliance reports and environmental performance reports;
- Being accountable for overall delivery and compliance with regulatory requirements including the GAME conditions of approval;
- To review and approve the construction EMMP;
- To review and approve the Construction Manager's induction and training program (and monitor implementation);
- To attend Health, Safety & Environmental Management meetings as required;
- To train supervisors / managers to maintain communication of the provisions of the EMMP to all employees in order to enable employees to conduct their work in a sustainable manner and adhere to the environmental requirements outlined in the EMMP; and,
- To develop and operate a plant in accordance with relevant environmental regulations and commitments made within the ESIA and EMMP.

20.2.2.2 The IPP Construction/Operational Manager

The Construction/Operational Manager is responsible for overall delivery of the project, including day to day activities on site, and performance of all activities and disciplines.

The duties and responsibilities of the Construction Manager shall include, but not be limited to, the following:

- The implementation and performance of the Site Health Safety and Environment (HSE) Plan;
- The implementation of the Construction Execution Plan;
- To input into the planning of the site temporary facilities, and manage the establishment of these facilities;
- To input into the scheduling of mobilization (and subsequent de-mobilization) of the construction supervision team;
- To input into the development of the construction schedule;
- To monitor site industrial relations and provide feedback to the construction director;
- To co-ordinate the construction supervision team and construction subcontractors within his//her area;
- To monitor the subcontractors compliance with their quality and inspection and test plans;
- To ensure the site co-ordination and performance of all construction subcontractors;
- To monitor subcontractors performance against their approved contract program and the overall construction schedule, and provide feedback to the construction director and the site team;
- To chair the weekly/monthly progress meetings as agreed with the construction director;
- To liaise with site engineering for the resolution of site technical queries;
- To prepare, and initial for agreement site instructions in accordance with the project applicable Terms & Conditions;
- To monitoring construction costs against approved budgets for the portions defined by the construction director. To identify and report any changes or potential changes to the work

that may impact on construction costs and/or schedule, and initiate corrective action as instructed by the site manager;

- To input into the construction weekly and monthly reports; and,
- To maintain a daily diary and monitor the upkeep of the construction supervisors daily logs.

20.2.2.3 The IPP Environmental Manager

The environmental manager will report to the construction manager and health and safety manager. Responsibilities include (but are not limited to):

- To develop, implement and adhere to a construction EMMP, to be approved by the health, safety and environment manager;
- To obtain all relevant statutory and non-statutory licenses that are the responsibility of the contractor for the construction phase;
- To coordinate and manage training of all staff in their respective project aspects prior to the commencement of commissioning and construction activities including coordination with the health, safety & environment manager.
- To ensure that all subcontractors are aware of their environmental management responsibilities;
- To manage day-to-day implementation of this EMMP;
- To undertake audits of all sub-contractors in accordance with the construction environmental management plan;
- To manage all monitoring in accordance with the construction EMMP;
- To establish environmental and social considerations during construction including environmental constraints on the project;
- To report directly and promptly to the HSE manager on all environmental and occupational health and safety matters including incidents and non-conformances;
- To conduct site inspections to ensure environmental management measures are effectively in place;
- To liaise with the HSE manager on and respond pro-actively to requests and instructions;
- To construct individual facilities in compliance with the clients environmental policy, and in accordance with relevant construction regulations, standards and best practice guidelines;
- To consider environmental and sustainability credentials in the procurement of materials, equipment and additional services (liaising with the HSE manager and client as appropriate);
- To ensure stakeholder consultation is conducted in alignment with the stakeholder engagement plan, liaising with client as appropriate;
- To identify key stakeholders and messages that need to be communicated;
- To contribute to the development of mitigation proposals;
- To consult with regulatory bodies regarding both the informal and formal permission and consent process;
- To evaluate, select, and work with sub-contractors to ensure management of environmental issues on the project;
- To be responsible for environmental considerations in working methods for all construction activities; and,

- To liaise/consult with local authorities and local communities.

20.3 Communication

Communications can be divided into internal communications, such as communications within the project team and design team and external communications, such as communications between the project team and other interested parties that may include regulators, contractors, the local community and local businesses.

The construction/operational project manager is responsible for monitoring on a weekly/monthly basis all communications between team members and other parties, and for ensuring that all matters relevant to the project are communicated to team members as quickly as possible.

The contractor project manager is responsible for implementing and monitoring internal communication on site.

Effective co-ordination and liaison on project activities is paramount to the successful implementation of the EMMP. The project management team should be committed to ensuring all issues requiring liaison and co-ordination are identified, and a responsible person (e.g. Project Manager) with the required skills and experience should be appointed to resolve any issues.

For the successful implementation of the EMMP, it is essential that all persons working for, or on behalf of, the Project who have responsibility to undertake work activities that have the potential to cause significant environmental impacts, including those arising from the design process are:

- Aware of this EMMP and associated management and monitoring plans;
- Aware of the relevant environmental regulations and guidelines, as outlined in Table 20-1 and detailed in the ESIA;
- Aware of the details and commitments outlined in the relevant permits and approvals; and,
- Appropriately trained and competent to fulfil their roles within the Project.

20.3.1 Internal Communication

Environmental information will predominantly be communicated by ensuring that all relevant parties have a copy of the EMMP and associated plans. The contractor environmental manager will keep a register of all issued copies of the plans and will circulate any amendments to copy-holders.

The project management team will develop additional means of communication wherever necessary which may comprise meetings between disciplines, presentations, workshops, and training where applicable.

A register of all appropriate internal environmental communication will be compiled and a process will be implemented to allow all actions to be dealt with accordingly. All relevant internal communications will be stored for the duration of the project and should be made available for audit on a monthly basis.

20.3.2 External Communication

An environmental communications register will be used to track incoming and outgoing external environmental communications and will include defined responsibilities and timescales for responding to communications.

The following measures should be undertaken as a minimum to ensure that all relevant parties are kept informed about the works during implementation:

- Stakeholders and the local community should be informed of and provided information on the works program. This can take the form of meetings, letters, and other means of communication as appropriate;
- Notice boards should be erected, as appropriate, at the perimeter of the site to inform local residents, businesses and commuters about the progress of the works and of upcoming construction activities;
- Contact details, including physical address and telephone numbers should be placed on the notice boards for general public enquiries and complaints; and,
- Where communities are likely to be subject to significant impacts or disturbance during construction then consultation should be undertaken with those likely to be affected to explain the nature and timing of the works.

20.3.3 External Complaints Procedure

An external complaints procedure will be developed to respond to any complaints received by the project during the construction works. This will be a documented system to respond to complaints received by letter, by telephone or in person. All complainants will receive an appropriate response within a defined period. The IPP will suitably consider each justified complaint, developing mitigation measures if necessary and alter the site environmental method statement, in discussion with the contractor project manager.

A complaints register will be kept by the construction/operations project manager and made available during any audits and inspections as required. The register will contain all the justified complaints that have been received (including summaries of complaints received orally), a copy of the response will be sent to the complainant and a summary of how the complaint was responded to (e.g. the imposition of a further mitigation measure), if relevant.

20.4 Induction and Training

For the EMMP to be successfully implemented, it is essential that all persons working for, or on behalf of the project, who have responsibility to undertake work activities that have the potential to cause significant environmental impacts are appropriately trained and possess the required competencies to fulfil their designated roles within the project.

The construction/operations project manager in consultation with the environmental manager will be responsible for ensuring all personnel working on site have received an initial site induction. Records of induction will be maintained in a training register. Ultimate responsibility for identifying all environmental training needs rests with the construction/operations project manager, who is also responsible for ensuring that all key staff and personnel responsible for environmental management working on the project are competent in their roles.

As part of the commitment to achieving effective management of the environment, awareness training will be provided to all appropriate project management and site personnel. The primary focus of this training will be to ensure that all team members understand the key environmental issues and requirements associated with the project and the importance of compliance with environmental management documents. Training will generally include briefing on environmental issues of concern as part of induction training and toolbox talks, and cover general and specific environmental responsibilities with respect to:

- The overall functionality of the CEMP;

- The importance of conformance with the environmental policy and procedures and with the requirements of environmental management documents (e.g. risk of prosecution, requirements to discharge planning conditions etc.);
- Roles and responsibilities in achieving conformance with environmental policy, and with the requirements of environmental documents, including emergency preparedness and response training;
- The potential consequences of departures from specified operating procedures;
    - General site issues;
    - Traffic and access;
    - Reporting procedures and reporting accountabilities;
    - Relevant environmental legislation and responsibilities;
    - Environmental aspects and potential impacts, including:
    - Air quality, including dust and odor;
    - Noise and vibration;
- Protected species/areas;
- Waste disposal and recycling;
- Soils and geology;
- Water quality;
- Hydrogeology.
- Housekeeping requirements;
- Pollution prevention; and,
- Incident management and use of the Environmental Emergency Response Plan (EERP).

Job specific training including competency assessment shall also be provided to staff carrying out activities with environmental implications such as waste or hazardous materials handling and disposal operations. This will be developed following a detailed training needs analyses.

Environmental awareness among site personnel should also be promoted through media such as notice boards and newsletters. All site personnel will be made aware of the structure and individuals by which environmental issues are managed.

The HSE manager will be responsible for training on hazards, risks, and emergency response connected to the EMMP.

20.5 Audit, Corrective Action & Reporting

The environmental performance of the Project will be monitored and evaluated by carrying out regular environmental audits/inspections of the project. The information from these reviews will be documented in an audit report passed to the project management team for action in the event of non-compliance.

Environmental audits will be conducted to evaluate the actual environmental performance of the project. The audit frequency will vary according to the environmental impact, legislative requirements and the auditor's assessment of the project team's competence.

Audits will be undertaken throughout the construction phase on a weekly/monthly basis by the IPP environmental manager and will focus on the following aspects of performance:

- Management system verification;
- Site arrangements, working conditions and site behavior (to ensure these are not damaging or posing risk to the environment);
- Relevant consents and permissions have been obtained; and,
- Work is being performed in accordance with the relevant environmental policies, objectives, management system requirements, licenses and consents, specifications and approved CEMP and method statements as applicable.

20.5.1 Non-Conformance, Corrective and Preventative Action

Non-conformances will be defined as one or more of the following:

- There is evidence of a serious failure or breakdown of a process or system;
- Lack of a procedure defining a particular process or activity, which, is required by a standard, legislation or EMMP and associated plans;
- Evidence of a lack of awareness or compliance with the requirements of an existing procedure, EMMP and/or method statement;
- A one off contravention of the requirements of a procedure or rule;
- Potential damage to the environment; or,
- Evidence of or the potential for breach of, environmental legislation.

Preventive action should occur either to prevent re-occurrence and/or to prevent potential non-conformities in the future. A project non-conformance, corrective and preventative action procedure form should be compiled in the event of a non-conformance. This details how the project will identify, handle and investigate non-conformances; will take action to mitigate any adverse impacts caused; and will be used for initiating and completing corrective and preventative action.

The project proponent, the IPP and construction/operations management teams will be responsible for ensuring that all non-conformances are appropriately investigated and for ensuring that the appropriate corrective actions are developed and implemented.

The construction/operations project management team will report all significant environmental non-conformances to the project management team. Agreed actions arising from any non-conformances raised by the site inspection/audit will be completed within an agreed timescale, monitored through to completion and in line with the requirements of the procedures.

A register will be kept by both the project proponent and the IPP environmental manager and the contractor project manager, of all non-conformances that will include, but not be limited to;

- a copy of the non-conformance report,
- a summary of the ensuing investigation; and,
- details of the proposed corrective action and evidence of its implementation.

20.5.1.1 Reporting

A report on each aspect-specific environmental audit will be produced on a monthly basis.

Each of the aspect-specific environmental audits will require a separate audit report, which will highlight;

- Any environmental legislative non-conformities;
- Any non-compliance to environmental method statement;
- Any required improvement;
- Any training requirements; and,
- Any other issue of concern identified by the audit.

Any environmental or social issue of significance identified during the audit, even if not related to the specific topic covered, will be highlighted as part of the audit report.

20.6 Associated Monitoring and Management Plans

Table 20-2 provides the environmental action plans for the various mitigation proposals described in the ESIA. These tables will be updated as the project proceeds through detailed design.

The action plans should be supplemented with all good practices as recommended throughout the ESIA.

The EMMP will be supported by a series of management plans. An outline of these plans are given in sections 20.6.1 to 20.6.7, and will be developed and updated through the project accordingly.

It should be noted that these are recommended plans based on the current phase of the Park, and other plans should be developed as appropriate.

20.6.1 Construction Environmental Management Plan

The IPP shall develop, implement and maintain a construction and commissioning phase Environmental Emergency Response Plan (EERP) and Construction Environmental Management Plan (CEMP) as supporting documents to this Environmental Management and Monitoring Plan (EMMP).

The plans will detail responsibilities and procedures for environmental management during construction, including (but not limited to):

- Minimum technical standard of construction plant;
- Competencies and training requirements of staff with environmental responsibilities, and lines of communication in the event of an emergency (including accidental releases of hazardous substances);
- A dust management strategy to reduce dust emissions from construction activities. This will include dust suppression of haul routes and covering loads on construction vehicles;
- Speed restrictions to reduce dust emissions from construction vehicles;
- Site clearance procedures that allow species to move away before clearance, rather than being trapped within the construction area;
- A construction site waste management plan and erosion and pollution prevention measures to reduce the risk of contaminants entering the natural environment;
- Identification and control of water discharges, to ensure the drainage capacity of the location, and to minimize erosion potential;

- Procedures to be implemented following an accidental release of hazardous substances, e.g. during refueling, including details of containment and recovery measures to be applied;
- Availability of pumps and spill mitigation materials such as absorbent granules to contain and recover hazardous substances releases; and,
- The development of a ‘chance find’ procedure to be undertaken during construction, in order to identify any previously unrecorded archaeological sites or un-stratified finds.

The contractor will undertake regular audits of the above management plans to confirm their on-going effectiveness.

20.6.2 Site Waste Management Plan

The IPP will develop a site waste management plan to identify in more detail anticipated wastes, and their quantities, and undertake waste planning for treatment and disposal. This will be prepared and implemented by the contractor before the production of any waste material.

The scope of the site waste management plan should cover the activities undertaken by contractors during the construction phase of the development. The management of waste on site will be undertaken in accordance with the waste management hierarchy. This hierarchy outlines that waste prevention and minimization are the first priority in managing wastes, followed by waste reuse and recycling. Disposal of waste will only be considered as a last resort.

The purpose of the site waste management plan is to facilitate the appropriate management of waste that will arise during the construction of the development. The plan will ensure that appropriate procedures are developed to prevent and/or reduce waste production, maximize recycling and minimize the potential adverse impacts associated with waste handling and disposal.

The site waste management plan will detail (but not be limited to):

- Waste and recycling objectives and targets;
- Waste segregation, storage, recycling and management procedures;
- Maximum storage times, and details of waste handling and labelling requirements;
- Selection, monitoring and auditing of waste contractors, and off site waste management facilities;
- Waste vehicle requirements;
- Competencies and training requirements of staff with responsibilities for managing waste storage areas;
- Procedures and lines of communication to be followed in the event of an emergency (including accidental releases of hazardous substances);
- Procedures to be implemented following an accidental release of hazardous substances, including details of containment and recovery measures to be applied; and,
- Procedures for the monitoring of waste generation, and collection and reporting data on this.

Staff will be trained on the on-site waste management systems (as appropriate), use of spill mitigation materials and equipment, and procedures to be followed in the event of emergency incidents, such as accidental releases of hazardous substances.

Regular audits of the management plans to confirm their ongoing effectiveness will be undertaken.

20.6.3 Traffic Management Plan

The purpose of the construction traffic management plan is to control movement of vehicles, plant and pedestrians that are present both on the construction site and adjacent road network and to ensure that safety is not compromised. It is recommended that this plan is revised if traffic figures are updated.

The objectives of the construction traffic management plan are:

- To provide protection to workers and the general public from traffic hazards that may arise as a result of the construction activity;
- To manage potential adverse impacts on traffic flows;
- To ensure network performance is maintained at an acceptable level; and,
- To minimize adverse impacts on users of the road and adjacent properties and facilities.

The IPP shall develop, implement and maintain a construction phase traffic and transportation management plan, for approval by the project proponent project management team prior to commencement of construction. This plan will detail as a minimum, the following:

- Responsibilities for traffic and transportation aspects, including daily transportation of workers and deliveries to site;
- Statement that only licensed and experienced drivers shall be employed;
- All vehicles, equipment and machinery shall undergo regular maintenance with manufacturer specifications;
- All drivers must adhere to speed limits;
- Procedures to be put in place for monitoring of increased traffic movements and associated environmental and safety concerns;
- Requirements for all drivers to be trained through third party agencies and possess competency certificates; and,
- Procedures to be implemented to monitor the condition of the roads used by the traffic associated with the Park, and a maintenance program to be implemented to ensure that roads remain in good condition.

The contractor will undertake regular audits of the management plan to confirm ongoing effectiveness.

In accordance with the IFC EHS general guidelines vehicles will not access the public highway wherever possible. Where vehicles must use the highway network, an appropriate access will be identified.

No vehicles shall leave the site with materials adhering to the wheels in a quantity which may result in its being deposited on the public highway, and creating nuisance, or hazard to vehicles. Suitable wheel washing equipment to avoid such problems shall be installed if appropriate, operated and maintained on the site until the development is completed.

20.6.4 Air Quality and Dust Monitoring and Management Plan

The EPC contractor will develop and implement a dust management plan (DMP), which may include measures to control other emissions, approved by the local authority. The level of detail will depend on the risk, and should consider (but not be limited to) the following:

- Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken;
- Make the complaints log available to the local authority when asked;

- Record any exceptional incidents that cause dust and/or air emissions, either on or off site, and the action taken to resolve the situation in the log book;
- Hold regular liaison meetings with other high risk construction sites within 500m of the site boundary, to ensure plans are coordinated and dust and particulate matter emissions are minimized. It is important to understand the interactions of the offsite transport/deliveries which might be using the same strategic road network routes;
- Undertake daily onsite and offsite inspection, where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary, with cleaning to be provided if necessary;
- Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the local authority when asked;
- Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions; and,
- Agree dust deposition, dust flux, or real time PM10 continuous monitoring locations with the Local Authority. Where possible commence baseline monitoring at least three months before work commences on site or, if it is a large site, before work on a phase commences. Further guidance is provided by the Institute of Air Quality Monitoring (IAQM) on monitoring during demolition, earthworks and construction.

20.6.5 Noise and Vibration Management Plan

The EPC contractor shall develop a noise and vibration management plan detailing measures to control noise and vibration emissions during construction and operation. This will include (but is not limited to):

- Details of the noise monitoring program and procedures for its implementation;
- Use of temporary sound-proof enclosures and anti-vibration measures, where appropriate, to reduce noise levels on site; and
- Maintenance procedures of all equipment in place to minimize noise from equipment.

The construction manager will undertake regular audits of the above management plans to confirm their ongoing effectiveness.

Prior to decommissioning/closure of the Park, the IPP shall evaluate potential noise and vibration sources associated with planned decommissioning activities, and establish measures to ensure these activities comply with the necessary noise guidelines at the sensitive receptors.

20.6.6 Closure and Decommissioning Plan

The IPP shall further develop the outline closure / decommissioning plan prepared for the ESIA, and attached to this EMMP over the life of the Park.

This will provide adequate detail for sound, and sustainable site decommissioning and closure. The closure / decommissioning plan should utilize the structure and content established within the outline closure / decommissioning plan, and build on this, refining and adding details as the Park develops. The structure and content of the outline closure / decommissioning plan shall be in compliance with IFC EHS general guidelines.

20.6.7 Social Impact Management Plan

Social impact management plans (SIMP) are generally prepared and implemented following completion of the project risk reviews and the ESIA process in cases where:

- Displacement of impact communities may occur and resettlement may be required;
- The project exists on indigenous lands, where customary or traditional land ownership applies and/or cultural heritage sites are located;
- There is potential for significant population influx;
- Significant health risks apply or are likely to apply; and,
- There is a requirement to undertake training of people from local communities to achieve local employment targets.

A number of positive socio-economic impacts have been identified as part of the impact assessment. These benefits may be maximized for the local community, through the implementation of the following recommendations:

- The contractor will be encouraged to make job opportunities during construction available to the local workforce, and promote engagement of the local population in the construction phase;
- The IPP should consider the provision of training during the construction phase, to increase local knowledge of the construction industry and in particular at the Al Jouf University to advance training in skills required for construction and operation of renewable energy projects;
- The contractor will consider the extent to which infrastructure provided within the construction camp can provide ongoing benefit to the local population;
- The IPP should establish social performance criteria for their suppliers, to promote the maximization of local sourcing of materials, local employment, and implementation of sound sustainable business practices;
- The IPP should continue stakeholder engagement in accordance with the stakeholder engagement plan; and,
- The IPP shall provide on-going community consultation and in particular provide guidance and assistance regarding use of alternative sites where appropriate.

20.6.7.1 Livelihood Restoration Plan

Livelihood Restoration plans should be developed in advance of construction following consultation with relevant stakeholders and community users. The plan should identify the level and type of compensation and should include non-monetary measures. The restoration plan should make special consideration of vulnerable groups and users, and ensure compensation is appropriate to their needs and is delivered in a manner which protects their right to any compensation.

20.7 Key Performance Indicators (KPI)

The IPP shall implement a monitoring and reporting strategy in the form of KPIs. These can be grouped into four main categories:

- Resource use – water, raw materials;
- Emissions to land – industrial waste (hazardous and non-hazardous);
- Emissions to air – Nitrogen oxide, sulfur dioxide, greenhouse gases; and,

- Emissions to water – nutrients and inorganic pollutants, heat.

The KPIs will be developed through detailed design and implemented for both construction and operation.

Example of applicable socio-economic KPIs can include:

- Percentage of construction workforce from within the local or provincial area;
- Number of students in receipt of Ministry of Energy, Industry and Mineral Resources sponsored training; and,
- Percentage of operational workforce trained with transferable industry skills.

20.8 Action Plan

The environmental action plans (EAP) in Table 20-1 provide a detailed list of the environmental recommendations and mitigation identified in the ESIA, which should be implemented on site at each phase of the Park. The EAP is a live document and should be developed throughout the life of the Park to ensure the Park delivers to the required standards and objectives.

The EAP, where appropriate, includes assumptions that have been made in the development of the ESIA assessment where non- compliance with these assumptions may change the overall assessment (e.g. air quality, noise and mobile plant etc.). Recommendations and/or actions identified in the ESIA to deliver positive/beneficial impacts are also identified.

The EAP should be revised to include any recommendations or conditions from the GAME and/or lending institution upon authorization of the Park. It should also include any conditions relating to environmental protection, enhancement monitoring or management associated with any permits or permissions from other statutory authorities as the project progresses.

20.9 EMMP Conclusions

This chapter has been developed based on the current known design and associated Environmental and Social Impact Assessment of the Park.

The successful delivery of the EMMP is dependent upon:

- Effective communications, both internal and external;
- Comprehensive and ongoing environmental awareness training for all staff tailored to their role;
- Engagement of environmental engineers in all phases of the Park to design out potential environmental issues and design in effective mitigation and management procedures;
- Development of comprehensive management plans and method statements for specific environmental issues (e.g. air quality etc); and,
- Rigorous on-site management of environmental issues and compliance with the site rules.

This EMMP should be reviewed and updated throughout the life of the Park to incorporate design and legislative changes.

Table 20-1: Relevant Legislation and Guidance

Reference Number	Legislation/ Guidance	Summary of relevant environmental aspects	Applicable Section
Air Quality and Dust			
A01	PME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles; Article 12
A02	PME Environmental Standard 19: Ambient Air Quality (2012)	Defines the thresholds, standards, and monitoring for ambient air quality	All
A03	PME Environmental Standard 2: Mobile Source Emissions (2012)	Defines the thresholds for various plant and vehicle emissions for construction and operation	All
A04	IFC Performance Standard 3: Resource Efficiency and Pollution Prevention	Guiding Principles for the management of emissions and prevention of pollution.	All
A05	IFC General EHS Guidelines (2007)	Ambient Air Standards and standards for emissions	Section1.1
		Air Quality Standards for Occupational Health	Section 2.4
		Guidelines for Construction Air Quality Management	Section 4.1
		Guidelines for Construction Dust Management (Occ. Health)	Section 4.2
A06	PME Environmental Standard 3: Point Source Emissions (2012)	Defines the thresholds, standards, and monitoring for point source emissions to air	All
A07	Institute of Air Quality Management Guidance on the Assessment of Dust from Demolition and Construction (IAQM, 2016)	Guidance on dust assessment and good practice to control dust emissions during construction and demolition projects.	Section 8
Noise and Vibration			
B01	PME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles; Article 13
B02	PME Environmental Standard 3: Noise Standards (2012)	Defines the thresholds, standards, and monitoring for Noise	All
B03	IFC General EHS Guidelines (2007)	Noise Standards and monitoring requirements	Section 1.7
		Noise and vibration Standards for Occupational Health	Section 2.3
		Guidelines for Construction Noise & Vibration	Section 4.1
B04	BS 5228:2009 Part 1	Guidelines for Construction Noise and mitigation	All
B05	BS 5228:2009 Part 2	Guidelines for Construction vibration and mitigation	All
B06	IFC EHS Guidelines: Wind Energy (2015)	Guidelines on the assessment of construction and operational noise effects of Wind Farms	All

Reference Number	Legislation/ Guidance	Summary of relevant environmental aspects	Applicable Section
B07	ISO 9613-2 (1996)	Primary standard used in the calculation of environmental sound propagation	All
B08	ETSU-R-97 The Assessment and Rating of Noise from Wind Farms	International best practice for assessing and rating noise impacts arising from wind farms within the UK	All
Water Management			
C01	PME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles; Article 13
C02	PME Environmental Standard 10: Drinking Water Standards (2012)	Defines the water quality standards for potable water	All
C03	PME Environmental Standard 17: Industrial and Wastewater Discharge Standards (2012)	Defines the standards for discharge of wastewater to treatment works and the environment, monitoring and permitting.	All
C04	PME Environmental Standard 20: Ambient Water Quality Standards (2012)	Defines the baseline standard for all water bodies, and provides the basis for monitoring and requirements for restoration.	All
C05	IFC Performance Standard 3: Resource Efficiency and Pollution Prevention	Guiding Principles for the management of water and prevention of pollutions.	All
C06	IFC General EHS Guidelines (2007)	Guidelines and standards for wastewater treatment and water quality management	Section 1.3
		Guidelines and standards for the recycling and re-use of water.	Section 1.4
		Guidelines for the supply of potable water, and water provision under occupation Health	Section 2.1
		Guidelines on the protection of water quality and quantity for the Community	Section 3.1
		Guidelines for the management of wastewater during construction.	Section 4.1
C07	IFC EHS Guidelines for Water and Sanitation	Guidelines for Water and Sanitation	All
Contaminated Land			
D01	PME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles;
		Minimization of environmental pollution, and restoration following incident	Article 11
		Minimize exposure to pollution, and handling of materials, chemicals or wastes	Article 12
		Pollution Prevention	Article 13
		Control of hazardous substances (storage and use)	Article 14

Reference Number	Legislation/ Guidance	Summary of relevant environmental aspects	Applicable Section
D02	PME Environmental Standard 9: Waste Classification	Guidance on the composition of the classification of types of waste (including hazardous) including toxicity leaching standards.	All
D03	PME Environmental Standard 13: Waste Handling and Storage	Guidance and standards for the segregation, storage on site (including storage receptacles) program for removal of waste, and pollution prevention.	All
D04	IFC Performance Standard 3: Resource Efficiency and Pollution Prevention	Guiding Principles for the management of resources and prevention of pollution.	All
D05	IFC General EHS Guidelines (2007)	Guidelines and standards for the management of hazardous materials onsite (including pollution prevention)	Section 1.5
		Guidelines for the management of small quantities of hazardous materials (e.g. oils, batteries etc)	Section 1.6
		Management of Contaminated Land (principals and guidelines)	Section 1.8
		Management of hazardous materials (storage and use) for Occupational Health	Section 2.4
		Construction management of contaminated land and use of hazardous materials.	Section 4.1
Ecological Management			
E01	PME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles; Article 8
E02	IFC Performance Standard 3: Resource Efficiency and Pollution Prevention	Guiding Principles for the management of resources and prevention of pollution.	All
E03	IFC Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	Guiding Principles for the protection and management of biodiversity, habitats, and ecosystem services	All
E04	KSA Royal Decree M/22 (1406)	Framework for the establishment of the Saudi Wildlife Authority	All
E05	KSA royal Decree M/12 (1415)	Provides legislation for the development of a system of protected areas, and regulations for the continued protection of wildlife and habitats.	All
E06	World Bank Environmental Assessment update 20: Biodiversity and Environmental Assessment (1997)	Guiding principles for assessing and mitigation biodiversity impacts from construction and operation.	All
Waste Management			

Reference Number	Legislation/ Guidance	Summary of relevant environmental aspects	Applicable Section
F01	PME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles; Article 12, 13 & 14
		Hazardous waste – rules and procedures	Appendix 4
F02	PME Environmental Standard 1: Waste Recycling	Guidance on the types of waste appropriate for recycling and promotes sustainable waste management	All
F03	PME Environmental Standard 8: Waste Acceptance Criteria	Guidance on the types of waste accepted at different waste facilities and the responsibilities of operators	All
F04	PME Environmental Standard 9: Waste Classification	Guidance on the composition of the classification of types of waste (including hazardous) to be used in conjunction with other PME Standards for defining waste management strategies.	All
F05	PME Environmental Standard 12: Waste Control and compliance	Guidelines for the management, tracking and monitoring of waste from generation to disposal	All
F06	PME Environmental Standard 13: Waste Handling and Storage	Guidance and standards for the segregation, storage on site (including storage receptacles) program for removal of waste, and pollution prevention.	All
F07	PME Environmental Standard 15: Waste Transportation	Guidance, policies and procedures for the management, tracking and monitoring of waste transportation including hazardous and dangerous waste.	All
F08	PME Environmental Standard 18: BPO Waste Disposal	Guidance for undertaking BPO assessment for determining the best method for disposing of waste utilizing the waste hierarchy.	All
F09	IFC General EHS Guidelines (2007)	Guidelines and standards for the management of hazardous materials	Section 1.5
		Guidelines and standards for the management of waste on site (including waste minimization, storage and transport)	Section 1.6
		Guidelines for the protection of community health from transport of hazardous waste	Section 3.5
		Emergency Preparedness	Section 3.7
		Construction management of waste, hazardous waste and occupational HSE.	Section 4.
F10	IFC Performance Standard 3: Resource Efficiency and Pollution Prevention	Guiding Principles for the management of resources and prevention of pollution (including management of hazardous materials.	All
General legislation			

Reference Number	Legislation/ Guidance	Summary of relevant environmental aspects	Applicable Section
G01	PME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All
G02	IFC Performance Standard 1: Assessment and management of Environmental and Social risks and impacts	Provides general guidance on the processes and procedures for the assessment and management of environmental impacts including stakeholder consultation	All
G03	IFC Performance Standard 2; Labor and Working conditions	Provides definitions and general guidance on minimum standards for employment of workforce	All
G04	IFC Performance Standard 4; Community Health Safety and Security.	Provides definitions and general guidance on managing impacts on the local community including degradation of ecosystem services and emergency response.	All
G05	World Bank Environmental Assessment Sourcebook Update: Environmental Management Plans	Provides guidelines on the production, contents and implementation of environmental management plans	All
G06	World Bank Environmental Assessment Sourcebook Update: Public Consultation in the EA process: A Strategic Approach	Provides guidelines on the engagement of the local community and stakeholders	All
G07	IFC/EBRD: Workers' accommodation: processes and standards. A guidance note by IFC and the EBRD	Guidance on the standards and requirements on the provision of workforce accommodation	All
G08	IFC General EHS Guidelines (2007)	Guidelines for the provision of HSE training and Awareness, traffic management and safety	Section 2.2 Section 4.2
G09	KSA Labor Law (2005)	Defines the working conditions and minimum welfare required for employment of all people within KSA	All in particular Chapters 1-4.
G10	KSA 9th Development Framework	Outlines the development program to ensuring sustainable economic growth in KSA.	All
G11	IFC Performance Standard 8: Cultural Heritage	Provides guidelines on identification of cultural heritage and outlines guiding principles for its' protection	All
G12	IFC Environmental, Health and Safety Guidelines for Wind Energy, 2015	Guidelines for the environmental, health and safety aspects of onshore and offshore wind energy facilities	All
G13	IFC Performance Standard 7: Indigenous Peoples	Guidelines on identification of indigenous peoples and outlines guiding principles for their protection, promoting sustainable developed in a culturally appropriate manner	All
G14	IFC Environmental, Health and Safety Guidelines for Water and Sanitation, 2007	Guidelines for the environmental, health and safety aspects of water and sanitation projects, applicable to septic tanks.	All

Reference Number	Legislation/ Guidance	Summary of relevant environmental aspects	Applicable Section
G15	IFC Environmental, Health and Safety Guidelines for Electric Power Transmission, 2007	Guidelines for the environmental, health and safety aspects of projects involving power transmission and electrical substations.	All
G16	Onshore Wind Health and Safety Guidelines, UK Renewable (2015)	Guidelines for managing health and safety for wind farm projects, including commonly applied techniques for managing planned and emergency situations.	All, particularly Part C

20.9.1 Action Plan

The following Environmental Action Plans (EAP) provide a detailed list of the principal environmental mitigation and recommendations identified in the ESIA, which should be implemented on site at each phase of the Park. The EAP is a ‘live’ document and should be developed throughout the life of the Park to ensure the Park delivers to the required standards and objectives.

The EAP should be revised to include any conditions or recommendations from the GAME and/or lending institution upon authorization of the Park. It should also include any conditions relating to environmental protection, enhancement monitoring or management associated with any permits or permissions from other statutory authorities as the implementation of the Park progresses.

Implementation of this action plan supports compliance with regulatory requirements and the mitigation of impacts in latter phases of the Park development.

Table 20-2: Action Plan

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
General Project Wide							
N/A	Further detailed design information	C	Update impact assessments in line with new detailed design information and information gathered from stakeholder engagement. Report in an Addendum. This is applicable to all chapters.	High	Project Proponent / IPP	ESIA all chapters	G01, G02

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
N/A	Management of construction impacts	C	Develop and implement Construction Environmental Management Plan and Environmental Emergency Action Plan (or update as appropriate).	High	IPP	CEMP, EERP	G05
N/A	Sustainable Development	C	Continue to identify potential sustainability benefits through construction including: • Prevent or minimize environmental pollution, conserve natural resources, minimize waste and value cultural heritage • Implementation of mitigations and recommended measures proposed within the ESIA, and the resultant EMMP and all procedures and action plans developed to support the EMMP	Medium	IPP	ESIA all chapters	G01, G10, G02, G06
N/A	Communications and Training	C	• Identify appropriate mechanisms for communication for each stakeholder, and engage prior to commencement of works • Implement stakeholder engagement plan • Provide contact details for complaints and violations	High	IPP	Stakeholder engagement plan	G06
Meteorology, Climate & Air Quality							
AQ1, AQ2	Potential dust inhalation/	C	The effects during the construction phase are temporary and the impacts will be short term and will	Low	IPP	ESIA Chapter 6	A02, A05, A06, A07

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
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	nuisance resulting from construction activities. Increase GHG emissions from the construction of the Park		only arise during specific construction activities. Following the application of the good practice dust control and mitigation measures it is considered that impacts at all receptors would be 'not significant' in accordance with the IAQM guidance.				
Soils & Geology							
SG1, SG4	Potential contamination of soils resulting from inappropriate discharge of aqueous effluents from construction activities and poorly maintained construction plant and equipment	C	Contamination should not be allowed to enter any watercourse/drainage channel and should be re-used or treated on site where possible Identification and control of wastewater discharges, in particular the sanitary wastewater discharges from the temporary construction site offices Ensure that all substances are stored in suitable, undamaged, containers; clearly marked with the type, nature and content of the material, to ensure that all staff are aware of the material and its properties Ensure the availability of pumps and spill mitigation materials such as absorbent granules, to contain and recover hazardous substance releases Plant used by the contractor on site is within its design life and has been properly maintained as per the manufacturer's instruction. Re-fueling of vehicles and other fluid transfers will only take place in	Low	IPP	ESIA Chapter 7	D01, D02, D03, D04, D05

<table>
<tr><th rowspan="2">Impact ID</th><th rowspan="2">Impact Description</th><th rowspan="2">Project Phase</th><th rowspan="2">Action</th><th rowspan="2">Priority Level</th><th rowspan="2">Responsibility</th><th colspan="2">Further information</th></tr>
<tr><th>ESIA/other document</th><th>Guidance/ Legislation reference</th></tr>
<tr><td></td><td></td><td></td><td>designated areas where there are impervious surfaces.
Construction waste management plan, designed to eliminate the risk of contamination entering the natural environment.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>SG2</td><td>Loss of potential future land use</td><td>C</td><td>Security fencing will only be installed around the construction camps and storage areas.</td><td>Low</td><td>IPP</td><td>ESIA Chapter 7</td><td>D01</td></tr>
<tr><td>SG5</td><td>Risk of erosion of soils through wind blow and wash out</td><td>C</td><td>Construction activities will avoid known minor wadi flow paths.
Minimize disturbance of ground conditions and soils.
Avoid stockpiling soils.</td><td>Low</td><td>IPP</td><td>ESIA Chapter 7</td><td>D01, D02, D03, D04, D05</td></tr>
<tr><td>SG6</td><td>Loss of soil resource due to modification of minor wadi flow paths</td><td>C, O</td><td rowspan="3">▪ Compliance with conditions of authorizations, resource consents, and designations;
▪ Awareness of and adherence to environmental objectives;
▪ Proper management of environmental risks associated with the Park;
▪ Maintenance of competence and training requirements of staff with environmental responsibilities;</td><td>Low</td><td>IPP</td><td>ESIA Chapter 7</td><td>D01, D02, D03, D04, D05</td></tr>
<tr><td>SG7</td><td>Loss of soil due to storm water runoff and erosion</td><td>O</td><td>Low</td><td>IPP</td><td>ESIA Chapter 7</td><td>D01, D02, D03, D04, D05</td></tr>
<tr><td>SG8</td><td>Impact upon soil from accidental leaks and spills</td><td>O</td><td>Low</td><td>IPP</td><td>ESIA Chapter 7</td><td>D01, D02, D03, D04, D05</td></tr>
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Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
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			▪ Lines of communication in the event of an emergency; ▪ Identification and control of wastewater discharges, in particular the sanitary wastewater discharges from the temporary construction site offices; ▪ Ensure that all substances are stored in suitable, undamaged, containers; clearly marked with the type, nature and content of the material, to ensure that all staff are aware of the material and its properties; ▪ Ensure the availability of pumps and spill mitigation materials such as absorbent granules, to contain and recover hazardous substance releases; ▪ Procedure to be implemented following the accidental release of hazardous substances during refueling of vehicles, including details of containment and recovery measures to be applied; and, ▪ Washout from the cleaning of ready-mix concrete trucks contaminated with cement, is highly alkaline. This should not be allowed to enter any drainage channel and should be re-used on site where possible. Where this				

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			is not possible, the water should either be treated for pH and suspended solids and discharged off-site, or transported untreated, for disposal off site. Untreated disposal is the least favored options for waste water. On site treatment of washout should be undertaken within a hard standing area which is bunded and contained. Water must then be collected and disposed of in a closed loop system, as per the requirements of IFC EHS standards 1.3 *Wastewater and Ambient Water Quality*. ▪ It is additionally advised that maintenance and lifespan requirements of plant and other vehicles to be used on site are laid out in advance of construction. This will allow the contractor sufficient time to perform proper maintenance and upkeep on required plant in advance of construction.				
SG9	Impacts upon soils and geology due to residual materials after breakout of concrete foundations and other demolition activities.	D	See recommended actions for construction.	Low	IPP	ESIA Chapter 7	D01, D02, D03, D04, D05

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
Hydrology & Hydrogeology							
HH1	Changes to flow routes and flood risk	C	Construction compounds, plant and equipment will be located beyond the influence of known flow routes. There will be no temporary storage of materials or material stockpiles within or adjacent to known flow routes.	Low	IPP	ESIA Chapter 8	C05, C06
HH2	Contamination of surface water resources	C	The requirements of the IFC EHS Guidelines with regard to spill response should be followed. The requirements of the IFC EHS Guidelines with regard to emergency preparedness and response should be followed. All sanitary wastes and hazardous liquids will be stored in compliance with the Section 1.3 *Wastewater and Ambient Water Quality* and Section 1.5 Hazardous Materials Management of the IFC EHS Guidelines and the GAME Environmental Standard for *Industrial and Municipal Wastewater Discharges.* All material and waste storage areas will be located beyond the influence of known flow routes.	Low	IPP	ESIA Chapter 8	C03, C04, C06

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			Re-fueling of vehicles and other fluid transfers will only take place in designated areas where there are impervious surfaces, outside of known flow routes. Where hard surfaces have the potential to collect fluids with the potential to impact upon hydrological or hydrogeological resources (e.g. car parks or vehicle maintenance areas), oil interceptors will be utilized as per the requirements of PME Environmental Standard 6 - *Storage and Material Reclaim Facilities Design and Operation.* This will prevent the introduction, through interception of any harmful fluids into groundwater and hydrological resources. The washout from cement mixers and the dry mix batching plant will be discharged to a designated containment and evaporation pond.				
HH3	Changes to flow routes and flood risk	C, O	See previous measures.	Low	IPP	ESIA Chapter 8	C03, C06
HH4	Contamination of surface water resources	C, O		Low	IPP	ESIA Chapter 8	C03, C04, C06
Noise & Vibration							

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
NO1 – NO4	Impact of construction noise and vibration on sensitive receptors	C	The good practice guidance presented within the IFC Guidelines are presented below. *"Noise reduction options that should be considered include:* ▪ *selecting equipment with lower sound power levels* ▪ *installing silencers for fans* ▪ *installing suitable mufflers on engine exhausts and compressor components* ▪ *installing acoustic enclosures for equipment casing radiating noise* ▪ *improving the acoustic performance of constructed buildings, apply sound insulation* ▪ *installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective*	Low	IPP	ESIA Chapter 9	B01, B02, B03, B04, B05

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
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			▪ *installing vibration isolation for mechanical equipment* ▪ *limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas* ▪ *re-locating noise sources to less sensitive areas to take advantage of distance and shielding* ▪ *siting permanent facilities away from community areas if possible* ▪ *taking advantage of the natural topography as a noise buffer during facility design* ▪ *reducing project traffic routing through community areas wherever possible* ▪ *planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas* ▪ *developing a mechanism to record and respond to complaints"* In addition to the example of good practice presented above, BS 5228: 2009 + A1: 2014 - Parts				

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			1 and 2 provide further guidance on effective methods for controlling noise and vibration emissions. It is anticipated that the following mitigation measures would be employed on site to ensure that noise and vibration levels are adequately controlled (all of which are considered to be examples of Best Practicable Means (BPM)): ▪ appropriate selection of plant and equipment, construction methods and programming. Only plant conforming with or better than relevant national or international standards, directives or recommendations on noise or vibration emissions will be used. Construction plant will be maintained in good condition with regards to minimizing noise and vibration emission; ▪ plant will be operated and maintained appropriately, with due regard for manufacturer recommendations. All vehicles, plant and equipment will be switched off when not in use; ▪ use of appropriate noise abatement site hoardings and screens, where appropriate. Where practicable, gates will not be located opposite noise sensitive receptors;				

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
			▪ careful selection of routes and programming for the transport of construction materials, spoil and personnel so as to reduce the risk of increased noise and vibration impacts during construction; ▪ vehicle and mechanical plant/ equipment used for the purpose of the works should be fitted with effective exhaust silencers, to be maintained in good working order and operated in such a manner so as to minimize noise emissions; ▪ the positioning of construction plant and activities to minimize noise at sensitive locations; ▪ equipment that breaks concrete by munching or similar, rather than by percussion, will be used where practicable; ▪ mufflers shall be used on pneumatic tools; ▪ the use, where necessary, of effective sound reducing enclosures. ▪ programming works so that the requirement for working outside normal working hours is avoided;				

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
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			▪ piling will be bored to protect sensitive receptors; ▪ Minimize the potential for higher vibration levels from the vibratory roller (used within the installation of access roads scenario), by taking into account the guidance within TRL report 429 (ensure that the vibratory roller is not started, stopped, or the direction of travel reversed close to sensitive receptors).				
N05	Operation noise and vibration impacts	O	Refer to IFC and BS 5228: 2009 + A1: 2014 - Parts 1 and 2 good practice measures. Consideration shall be given to both the sound power level of the turbines and the siting of the turbines within the final mitigation strategy.	Low	IPP	ESIA Chapter 9	B01, B02, B03, B04, B05
N06	Decommissioning noise and vibration impacts	D	See previous measures.	Low	IPP	ESIA Chapter 9	B01, B02, B03, B04, B05
Landscape and Visual							
LA01 – LA03	Alteration of landscape during construction phase due to construction of access tracks and the Park.	C	Stakeholder consultation will confirm the significance of this impact and should be undertaken ahead of construction to ensure appropriate mitigation measures are developed.	Low	Project Proponent / IPP	ESIA Chapter 10	G01, G02

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
LA04, LA06	No direct impact Perceived indirect impact associated with the alteration of landscape character as a result of the Dumat Al Jandal Wind Energy Park in the adjacent landscape character type	O	Stakeholder consultation will confirm the significance of the operational impact and from this exercise, mitigation measures will be developed. Security fencing would exclude individuals from accessing the development site itself. Standard, embedded mitigation measures to reduce landscape and visual impacts would be adopted in the first instance however. These would include all of the turbines having the same rotor diameter and hub height and turning in the same direction at broadly the same speed. The layout of the turbines is illustrated within chapter 4 - Detailed Description and Layout of the Proposed Development. The turbines would be of a traditional three bladed horizontal axis design with tubular steel towers and nacelles. Research (Stevenson and Griffiths, 1995) has confirmed that tubular steel towers reduce visual clutter and are preferred to lattice or pylon-like generator towers. Turbine transformers, in line with larger turbine designs, would normally be mounted within the machines to reduce visual clutter. If the transformers are external to the turbine then an appropriate color which diminishes their visual impact should be adopted. In relation to the characteristics of the site and surrounding landscape, a sand color or light brown	Low	Project Proponent / IPP	ESIA Chapter 10	G01, G02
LA05	Direct impact associated with the alteration of landscape character due to the introduction of Dumat Al Jandal Wind Energy Park	O		Moderate	Project Proponent / IPP	ESIA Chapter 10	G01, G02
LA09	Direct impact associated with the alteration of the view from the receptor Marid Castle	O		High	Project Proponent/IPP	ESIA Chapter 10	G01, G02

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
LA07 – LA12	Alteration of the view from the receptor. Introduction of Dumat Al Jandal Wind Energy Park within landscape	O	would be most appropriate. The turbines would all be a similar color and finish so as to promote visual integration.	Low	Project Proponent / IPP	ESIA Chapter 10	G01, G02
Terrestrial Biodiversity							
TB01 – TB10	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury Disturbance Pollution	C	All medium-voltage and communication cabling connecting the wind turbine generators to the sub-stations will be underground. During detailed design of the Park, the IPP will review the micro-siting of the wind turbine generators to achieve a minimum stand-off distance of 70m from blade tip to the edge of the plateau. Where there is a requirement to remove vegetation, this should preferably be undertaken during the winter months when there is less risk of impacting on nesting birds and when other faunal populations which are dependent on these resources are less active. If there is a requirement to remove vegetation during the spring or autumn periods, a competent ecological professional should first complete breeding bird checks. If evidence of breeding bird activity is recorded, clearance should be postponed	Low	IPP	ESIA Chapter 11	E03, E05, E06

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
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			for up to 21 days or as soon as the young have fledged. Pre-construction surveys for the Egyptian spiny tailed lizard will be undertaken prior to the construction of internal roads, crane lifting pads and the construction of wind turbine generator foundations. If burrows are recorded within the construction footprint, a program of trapping and translocation will be implemented. Prior to site clearance works, it is recommended that a competent terrestrial ecologist completes a walk-over survey. The objective of the survey is to ensure that the baseline conditions of the site remain the same and have not changed. If active large mammal burrows (i.e. red fox) are recorded, it is recommended that a competent ecologist oversees the exclusion and possible translocation of these species. Although not required by law, this is considered to be in the interests of animal welfare.				
TB12	Loss of recreational amenity	C	Engagement with local communities is undertaken so local communities understand the phasing of the development and impact on informal gardens within the boundary of the Park. Working in partnership, the IPP and hunters should identify safe corridors and zones for access based on the phasing of construction, and develop plans to mitigate and compensate for the loss of informal gardens. These actions will minimize the impact of displacing local	Low	Project Proponent / IPP	ESIA Chapter 11	E02

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
			communities who access the site to adjoining areas, beyond the boundary of the Park, during the construction period.				
TB14, TB15, TB16	Bird / bat collision with wind turbines, disturbance	O	On the basis of the information gathered at the development site to date there is potential for moderate impacts to migratory species, particularly the most abundant target species, steppe buzzard. Although the estimated collisions are low compared to the numbers of birds recorded at the development site it remains of significance that regular mortality is predicted for the lifetime of the development, not including other migrant species in smaller numbers. Post-construction monitoring is recommended to provide additional information on how the bird species present will respond to the development of the Park. Post-construction monitoring should include, although not be limited to, the following: • a minimum of three years' post-construction monitoring; • undertaken by minimum of two suitably experienced ornithologists at all times whilst on-site; • focus on peak autumn migration period (September and October); • migratory bird surveys focussed on assessing the behaviour of target species passing through the development site; and	Low	IPP	ESIA Chapter 11	E03, E05, E06

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
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			• periodical carcass searches and associated analysis of data to provide an estimate of mortality due to collision in any given migration period, including; o scavenger removal rate trials (outside of the development site); and o searcher efficiency trials. The results of post-construction monitoring should be reported on an annual basis. If impacts are found to be greater than those predicted within the baseline ornithological report, and those discussed within the ESIA, further considerations of site-specific mitigation measures will be made. These mitigation measures may include, although not be limited to, the following: • appointing suitably experienced ornithologists on-site to request temporary shutdown individual turbines, during the peak autumn migration period, if large numbers of migrating birds are observed on course for the turbine area at collision risk height; • consideration of automated technologies which can detect, and provide direct acoustical warning to, birds approaching turbines or those detected within the turbine area; and				

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
			consideration of automated technologies which can detect, and shutdown individual turbines, when birds are in proximity to operational turbines.				
TB20, TB21	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury Disturbance Pollution	D	Refer to mitigation measures for construction phase.	Low	IPP	ESIA Chapter 11	E03, E05, E06
Archaeology & Cultural Heritage							
CH01	Partial or total removal of any unknown buried archaeological remains or un-stratified archaeological finds, including those potentially associated with Zubayda's Road	C	The development of a 'chance find' procedure is proposed for the Park, to be undertaken during construction, in order to identify any previously unrecorded archaeological sites or un-stratified finds. This procedure will be outlined and included within the CEMP Further consultation with Saudi Commission for Tourism and Antiquities shall be undertaken by the IPP	High	IPP	ESIA Chapter 12, CEMP	G11
Traffic & Transport							

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
TT01	Increased traffic volume due to introduction of construction traffic	C	The IPP must prepare a Logistics, Traffic and Transportation plan for the delivery of wind turbine components to the development site, this plan must be prepared in accordance with the recommendations shown in the IFC EHS Guidelines in order to ensure that full consideration is given to the potential impacts upon individuals and communities resulting from the increased risk of traffic accidents associated with the construction and decommissioning of the Park. This plan must ensure that road closures and diversions are kept to a minimum, and wherever practicable and safe to do so, peak transportation hours must be avoided to reduce impacts on commuters and other road users. The plan must also include commitment for quarterly road safety driver training and annual defensive driving training for direct employees and the supply chain. The development of the plan must be undertaken in full consultation with stakeholders, including the emergency services, and the local community. This is to ensure full engagement of those likely to be impacted by road closures, diversions and policy escorts; and to minimize the impacts of disruption.	Medium	IPP	ESIA Chapter 13, TMP	G08
TT02	Road traffic accidents	C		Medium	IPP	ESIA Chapter 13, TMP	G08

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
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			The plan should include active monitoring during the transportation of wind turbine components, and this should include surveys of the structural integrity of roads to identify potential damage and implement repairs.				
TT03	Exceedance of operational capacity	C	Prior to the preparation of the Logistics, Traffic and Transportation plan, a robust Logistics, Traffic and Transportation Study must first be completed. This plan must ascertain the requirements for infrastructure upgrades and other works necessary to allow the safe passage of oversized and heavy specialist transportation vehicles. The findings of this study should be analyzed and where possible, route selection should seek to avoid and minimize the requirements for infrastructure upgrades and other works (e.g. relocation of utilities, increasing the height of overhead transmission and telecommunication lines and structural reinforcement of culverts and underpasses).	Medium	IPP	ESIA Chapter 13, TMP	G08
Socio-Economic							
SE05, SE06	Reduced access to land and impacts on existing livelihoods	C/O	Minimize area of land required during construction where possible. Provide on-going community consultation and in particular provide guidance and assistance regarding use of alternative sites. Livelihood restoration plans should be developed in advance of construction following consultation with relevant stakeholders and community users.	High	IPP	ESIA Chapter 14	G02, G06, G10

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SE01, SE02, SE03	Economic growth and employment opportunities during construction	C	Promote engagement with the local population Consider provision of training during construction Consider the extent to which infrastructure provided within the construction camp can provide ongoing benefit to the local population	Low	Project Proponent / IPP	ESIA Chapter 14	G02, G06, G10
SE07	Economic growth and employment opportunities during construction and operation	O	Consider use of design specifications to promote use of local suppliers, and sourcing of materials from local, regional and national suppliers where possible to support economic growth and indirect employment. Work with the local community to promote employment opportunities for the Al Jouf residents. Consider establishing a training program for local students. Continue stakeholder engagement in accordance with the Stakeholder Engagement Plan.	Low	Project Proponent / IPP	ESIA Chapter 14, stakeholder engagement plan	G02, G06, G10
SE09	Impact on existing livelihoods and reduced access to land	D	Implementation of Stakeholder Engagement Plan: • Maintain links with communities, respond to concerns and provide guidance and assistance regarding use of alternative sites.	Low	Project Proponent / IPP	ESIA Chapter 14, stakeholder engagement plan	G02, G06, G10
			Utilities Infrastructure				

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
UT1, UT2	Disruption or overloading of the Supply Infrastructure	C/O	No specific actions identified at this stage of design. Consultation with stakeholders should continue, in particular with utility providers. The SEC has already confirmed that there will be no restrictions to the power from the wind energy park feeding into the national grid. The utilization of utilities should be monitored during each phase of the project to develop an understanding of consumption rates and enable the implementation of continuous improvement measures to reduce consumption.	Low	IPP	ESIA Chapter 15	
UT4	Interference of telecommunication infrastructure	O	In addition to undertaking further consultation with the owners of the masts, prevention and control measures to address impacts to telecommunications systems include the following: • Modify placement of wind turbines to avoid direct physical interference of point-to-point communication systems; • consultation with relevant operators can assist in establishing the location of telecommunication links and relevant buffers to be applied in order to minimize impacts; • Install a relay next to the wind farm; • Modify the existing aerial; and, • Install an amplifier to boost the signal • If degradation is noticed in the operational phase of the project, there are a number of mitigation methods available. These include:	Moderate	IPP	ESIA Chapter 15	

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			o replacing the receive antenna with one that has a better discrimination to the unwanted signals, o relocating either the transmitter or receiver, or o switching to an alternate means of receiving the information (fiber-optics or other means).				
Waste Management							
WM1	Storage and disposal of non-hazardous waste	C	Develop and employ a construction waste management plan	Low	IPP	ESIA Chapter 16, SWMP	F05, F06, F07, F08, F09, F10
WM2	Storage and disposal of hazardous waste	C	Hazardous wastes derived from the construction activities will be stored temporarily on site prior to being disposed of in an authorized GAME Sanitary Landfill – Class I. The Contractor will be required to prepare an implement an emergency response procedure.	Low	IPP	ESIA Chapter 16, SWMP	F02, F03
WM3, WM4, WM5, WM6	Exceedance of operational capacity at local waste management facilities due to excess waste generated through demolition of buildings/breaking	C / O / D	Prepare a waste management plan to ensure proper phased recycling and disposal of construction wastes The understanding of local waste management infrastructure is subject to further stakeholder consultation by the IPP. A decommissioning Site Waste Management Plan will be developed by the IPP in consultation with local stakeholders, waste management contractors	Low	IPP	ESIA Chapter 16, SWMP	F02, F03

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
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	up of concrete at development site		and equipment suppliers (i.e. suppliers of wind turbines).				
Health and Safety							
HS01a – HS01d	Risk to health, especially respiratory disorders and chronic respiratory diseases, from exposure to air pollution including dust, diesel particulates and NOx	C	A dust management plan is recommended. Consideration of: • Changes to construction process and plant to minimize noise impacts • Organization of program and workforce to ensure rotation of staff • Development of comprehensive training program • Provision of PPE where required • Implementation of monitoring and health surveillance measures during construction	Low	IPP	ESIA Chapter 17, DMP	G03, G08, G09
HS02	Risk to health from contaminated water supplies	C	Adherence to quality control measures for tanked water supplies	Low	IPP	ESIA Chapter 17	G03, G08, G09
HS03	Motor vehicle accidents	C	A Logistics, Traffic and Transportation plan would be developed for the construction period of the Park. This would ensure that road closures and diversions are kept to a minimum, and wherever practicable and safe to do so, peak transportation hours must be	High	IPP	ESIA Chapter 17	G03, G08, G09

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			avoided to reduce impacts on commuters and other road users. The plan would also include a commitment for quarterly road safety driver training and annual defensive driving training for direct employees and the supply chain. The MOT 'Exceptional Loads' 01-77 policy outlines the permitting requirements for transporting exceptional loads and the specifications which constitute such a load. Requirements are laid out which must be fulfilled in order to obtain a permit. These include: ▪ Specifications of vehicles. ▪ Description of the load to be transported. ▪ The pre-submission time required to obtain a permit. The standard also outlines commitments which must be met by the driver of the vehicle. These include: ▪ Commitment to follow the pre designated and approved route. ▪ Commitment to adhere to a pre designated and approved speed limit. Permits, once issued, are valid for one trip, must be used during daytime hours only, and may not be				

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			used over weekends or public holidays. Police escorts will be utilized and active monitoring completed during the transportation of large components.				
HS04a - HS04e	Impacts on occupational health and safety	C	Implementation of international best practice in training, monitoring, HSE guidelines and practices. Introduction of a program which addresses culture and behaviors on site. Corporate policy and engagement with staff, suppliers and contractors on safety practices implemented on site. The Onshore Wind Health & Safety Guidelines (2015) which provide a comprehensive set of guidelines for safe working procedures during construction, operation and maintenance of onshore wind turbines, will be followed throughout the lifecycle of the Park. An Environmental Emergency Response Plan (EERP) will be developed which will detail the response to severe injuries/accidents. A comprehensive safety management program will be developed for the site in order to prevent the EERP having to be implemented.	Medium	Project Proponent / IPP	ESIA Chapter 17	G03, G07, G08, G09, GO12, G13, G14, G15, G16

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
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			Early engagement with local service providers should be undertaken. This consultation should include all emergency services. Exclusion zones should be established around construction activities when working at height is undertaken, and only approved personnel should be allowed to enter the exclusion zone. The IFC EHS Guidelines for Wind Energy (2015) and the Onshore Wind Health & Safety Guidelines (2015) set out a process for remote and lone working, which will be followed during construction. Plans for managing accidents in remote locations will be set out in the EERP. Management of lifting operations will range from detailed calculations and hazard studies carried out in advance by a specialist team, to basic simple checks on the load and equipment, carried out by a competent person before executing the lift. The IFC EHS Guidelines for Wind Energy (2015) and the Onshore Wind Health & Safety Guidelines (2015) will be followed for managing the risk of construction activities in confined spaces.				

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						ESIA/other document	Guidance/ Legislation reference
			Audits of worker accommodation should be undertaken in accordance with the IFC and the European Bank for Reconstruction and Development (EBRD) guidance note: Worker's Accommodation: Process and Standards (IFC 2009).				
HS05a, HS05b	Increased risk of contracting communicable or non-communicable diseases	C	Comprehensive health screening program for workers will be developed in compliance with the Kingdom of Saudi Arabia regulations. Training and awareness on issues such as infection control and health promoting activities.	Medium	IPP	ESIA Chapter 17	G03, G08, G09
HS06	Collision with construction plant and equipment	C	Exclusion zones should be established around construction activities during hazardous operations and no unauthorized personnel or members of the public should be allowed to enter the exclusion zone. The local community should be fully engaged prior to commencement of construction activities to ensure community is made aware of the risks.	Medium	Project Proponent / IPP	ESIA Chapter 17	G03, G08, G09
HS07	Blade throw from wind turbines	O	▪ Minimize the probability of a blade failure by selecting wind turbines that have been subject to independent design verification/certification (e.g. IEC 61400-1), and surveillance of manufacturing quality.	Low	IPP	ESIA Chapter 17	G03, G08, G09, G12, G16

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
			▪ Ensure that lightning protection systems are properly installed and maintained. ▪ Carry out periodic blade inspections and repair any defects that could affect blade integrity. ▪ Equip wind turbines with vibration sensors that can react to any imbalance in the rotor blades and shut down the turbine if necessary.				
HS08	Motor vehicle accidents	O	A Logistics, Traffic and Transportation Plan would be developed for turbine component replacements and maintenance. Training and awareness on issues such as defensive driving will be provided to the workforce	Low	IPP	ESIA Chapter 17	G03, G08, G09
HS09	Health and safety	O	Comprehensive safety management plans must be developed for the operation phase of the Park to ensure the effective management of risk in accordance with IFC EHS Guidelines for Wind Energy (2015), the IFC EHS Guidelines for Electric Power Transmission and Distribution (2007), the IFC EHS Guidelines for Water and Sanitation (2007) and the IFC General EHS Guidelines (2007).	High	IPP	ESIA Chapter 17	G03, G08, G09, G14, G16

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
HS10	Interference with aviation	O	▪ Consult with the relevant aviation authorities before installation, in accordance with air traffic safety regulations ▪ When feasible, avoid siting wind energy facilities close to airports and within known low-flying areas or flight paths ▪ Use anti-collision lighting and marking systems on towers and/blades and consult with the relevant aviation authorities to determine appropriate lighting and marking requirements in line with national standards.	Low	IPP	ESIA Chapter 17	G03, G08, G09
HS11	Electromagnetic interference and radiation	O	▪ Modify placement of wind turbines to avoid direct physical interference of point-to-point communication systems; consultation with relevant operators can assist in establishing the location of telecommunication links and relevant buffers to be applied ▪ Install a directional antenna ▪ Modify the existing aerial ▪ Install and amplifier to boost the signal	Low	IPP	ESIA Chapter 17	G03, G08, G09

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Guidance/ Legislation reference
HS12	Trespassing and climbing of wind turbines	O	Fencing to be construed around each turbine to prevent unauthorized access.	Low	IPP	ESIA Chapter 17	G03, G08, G09

20.10 Environmental Action Plans – Outline Closure / Decommissioning Plan

20.10.1 Introduction

The Outline Closure / Decommissioning Plan addresses the cessation of the Wind Energy Park, the decommissioning of wind turbines and equipment and rehabilitation of land.

The impacts of decommissioning have been identified and assessed in the ESIA. This Outline Closure / Decommissioning Plan provides an initial high level view of how these impacts will be mitigated as part of the project closure strategy.

It must be emphasized that the expected life of the Park is 25 years, and the identification of mitigation measures is only indicative at this stage. The need for specific measures shall be regularly reviewed throughout the lifecycle of the Park. The Park closure strategy shall be regularly reviewed and a detailed closure plan developed and tailored in light of increased data and knowledge obtained through the various stages of the development.

The following sections provide the structure and outline detail of the Closure / Decommissioning Plan, which is to be further augmented and developed as the development progresses.

The IPP shall update this Outline Plan and prepare a Decommissioning Plan during detailed design which is to be made available prior to commencement of operations. The IPP will keep this under review throughout the life of the Park and progressively develop and update a Detailed Closure / Decommissioning Plan. This Detailed Closure / Decommissioning Plan shall provide adequate detail for technically sound and sustainable closure and decommissioning and be cognizant of the outcome of ongoing stakeholder engagement.

20.10.2 Contextual Information

The ESIA is the primary source of contextual information on the Park, providing information on detailed description and layout of the Park and in each aspect section. Future iterations of the Closure / Decommissioning Plan shall summarize relevant contextual information so as to allow the Plan to act as a standalone document.

20.10.3 Closure / Decommissioning Vision

While the closure / decommissioning vision will be developed further in consultation with stakeholders, it will essentially be to close the wind energy park. The following sections of this Outline Closure / Decommissioning Plan and its future iterations present the means by which this vision is to be achieved.

20.10.4 Legislative Requirements

Table 20-1 provides detailed of the legislative requirements of the Park. Future iterations of the Closure / Decommissioning Plan will outline the legislative requirements specific to the closure and decommissioning of the project.

20.10.5 Stakeholder Engagement

The Stakeholder Engagement Plan provides the plan for the project proponent's and the IPP's ongoing engagement. Stakeholder engagement activities shall capture government, community and workforce views on closure and decommissioning, and the results of these shall be captured and summarized in future iterations of the Closure / Decommissioning Plan.

20.10.6 Closure / Decommissioning Objectives and Targets

Objectives are overall goals to be achieved through closure / decommissioning; targets represent the detailed performance requirements that need to be set and met to achieve the objectives. The following sections provide initial objectives and targets for the Project closure / decommissioning.

20.10.7 Closure / Decommissioning Objectives

The closure / decommissioning objectives for the Park are to:

- Undertake closure / decommissioning in accordance with all applicable national and international requirements; and,
- Leave a rehabilitated site that is stable and non-contaminating.

These objectives are to be revisited and updated in future iterations in light of ongoing stakeholder engagement during the development of the Park.

20.10.8 Closure / Decommissioning Targets

The closure / decommissioning objectives shall be developed into measurable targets against which the Project's performance can be measured. Proposed targets will be worked up following stakeholder engagement and reported in future iterations of the closure / decommissioning plan.

20.10.9 Closure roles and responsibilities

Responsibility for the development of the Closure / Decommissioning Plan lies with the project proponent and the IPP and its project management team through the lifecycle of the Park.

The roles and responsibilities detailed in section 3.2 of this EMMP shall be applied to closure / decommissioning activities, and augmented and updated as appropriate to reflect the activities to be undertaken as detailed in the Closure / Decommissioning Plan.

20.10.10 Anticipated closure and decommissioning activities

The closure / decommissioning activities are to be defined during detailed design and will be reported in future iterations of the Closure / Decommissioning Plan.

20.10.11 Assessment of environmental and social impacts / risks of closure / decommissioning

Each section of the ESIA includes consideration of the potential impacts associated with closure / decommissioning in accordance with the methodology. The impacts associated with closure and decommissioning identified by the impact assessments have been assigned mitigation measures as appropriate, and these are detailed within the relevant sections of the ESIA.

Future iterations of the Closure / Decommissioning Plan shall review and assess the potential environmental and social impacts associated with proposals for closure / decommissioning, identify risks, and assign mitigation measures to those impacts and risks. These shall form the basis of the specific closure / decommissioning activities to be undertaken and implemented through the Plan.

20.10.12 Final land use, form and access

The final land use is proposed to be returned to its previous state.

20.10.13 General closure / decommissioning activities

Through regular update and revision of the Closure / Decommissioning Plan throughout the lifecycle of the Park, the project proponent and the IPP shall progressively define and refine the closure and decommissioning activities required to achieve the closure / decommissioning vision, and associated objectives and targets. The following sections provide the structure to document and communicate these activities. The outline provided may be updated and amended to suit the requirements of the Park as necessary.

Over and above the specific topics addressed in the following sections, the IPP shall update, implement, maintain and audit the EERP and EMMP to ensure the documents remain adequate and effective for the closure / decommissioning phase.

20.10.14 Site safety and security

This section of the closure / decommissioning plan should address the following:

- Closure / Decommissioning Risk Assessment
- Safety Procedures and installation of site safety and security measures
- Public information and education
- Emergency response

The project proponent and the IPP shall provide further details of its proposals for site safety and security in future iterations of the Closure / Decommissioning Plan.

20.10.15 Decommissioning

This section of the closure / decommissioning plan should address the following:;

- Decommissioning, demolition and site clearance
- Site investigation and decontamination
- Management of decommissioning wastes

The project proponent and the IPP shall provide further details of its proposals for decommissioning in future iterations of the Closure / Decommissioning Plan.

20.10.16 Closure

This section of the closure / decommissioning plan should address the following:

- Final Park closure

The project proponent and the IPP shall provide further details of its proposals for closure in future iterations of the Closure / Decommissioning Plan.

20.10.17 Workforce retrenchment

This section of the closure / decommissioning plan should address the following:

- Consultations and planned workforce reduction
- Severance terms, non-discrimination, grievance and appeal procedures
- Re-assignment, resettlement and training support

The project proponent and the IPP shall provide further details of its proposals for workforce retrenchment in future iterations of the Closure / Decommissioning Plan.

20.10.18 Social management

This section of the closure / decommissioning plan should address the following:

- Managing cessation of local procurement
- Managing migrant outflows

The project proponent and the IPP shall provide further details of its proposals for social management in future iterations of the Closure / Decommissioning Plan.

20.10.19 Long term environmental management

This section of the closure / decommissioning plan should address the following:

- Post closure monitoring of soil, groundwater, ecological receptors

The project proponent and the IPP shall provide further details of its proposals for long term environmental management in future iterations of the Closure / Decommissioning Plan.

21. Environmental Emergency Response Plan

21.1 Introduction

This chapter sets out the Environmental Emergency Response Plan (EERP) for the Dumat Al Jandal Wind Energy Park (the Park). This EERP contributes towards meeting of the International Finance Corporation (IFC) Sustainability Framework Performance Standards 1: *Assessment and Management of Environmental and Social Risks and Impacts*; and 4. *Community Health, Safety and Security.*

21.1.1 Purpose of the Environmental Emergency Response Plan

The purpose of the EERP is to prevent major accidents in the first instance. If an accident does occur, the EERP will set out a framework for the mitigation of the impact on human health and the environment. The Independent Power Producer (IPP) will ensure these requirements are met by identifying process related risk and developing suitable control measures and implementing procedures, to be followed in response to an emergency event or disaster situation during the construction or operation of the Park. The EERP will be communicated by the IPP and made accessible to all employees and personnel working on the Park.

The IPP will review and update the EERP as the design progresses and as more detailed information of the activities involved in the construction and operation of the Park become available. This will allow for a more informative review of potential operational accident and emergency situations, as well as more detailed control measures and response procedures. An EERP review schedule will be implemented, with review taking place during each new phase of the Park and/or following modifications to the activities involved in the construction and operational phases.

Procedures required by the EERP will be consolidated when undergoing development to provide clear instruction to the IPP personnel on the step-by-step approach to be taken and implemented in the event of an accident or emergency situation occurring.

In compliance with the stakeholder engagement plan, stakeholder and community consultation will be ongoing during the development of the EERP. This will enable stakeholders and the community to influence the development and implementation of this plan, in particular the response procedures. This is in compliance with IFC Performance Standard 4.

21.1.2 Project related Risks

There are a number of hazards associated with the construction, operation and decommissioning of the Park.

Activities involved in the enabling works are likely to include:

- Fabrication of access roads to and from the development site;
- Grading and levelling of the development site to prepare for the installation of foundations;
- Excavation of cable trenches and other ground works required to install electrical infrastructure; and,
- Installation of two developer construction compounds and associated temporary infrastructure.

Activities involved in the construction works:

- Allocation of work and laydown areas;
- Installation of concrete turbine foundations, crane pads and safe working areas;
- Assembly of wind turbines;
- Construction of an SEC collector station, two electricity sub-stations and associated infrastructure;
- Construction of three meteorological stations; and,
- Civil and structural activities including the construction of new foundations.

It is assumed that the Park will require 180 construction workers per phase, as well as 80 operations and maintenance jobs.

The IPP will take steps to identify the activities where the greatest risk of accident or emergency exists. A detailed review of the activities taking place during the construction, operation and decommissioning of the Park will be undertaken by the IPP to identify potential accident and emergency situations. Consideration will be given to factors including probability of occurrence and the greatest loss as a result of the accident or emergency situation happening.

A risk assessment will then be completed, covering both operational accidents and natural incidents. The assessment of risk will be reviewed on a periodic basis and whenever a change, for example, the introduction of new, or change to existing, people, infrastructure, plant or activities, introduces a new potential accident or emergency situations. Specific occupational hazards for wind energy facilities include working at height; working in remote locations; working in confined spaces, and lifting operations.

Once risk has been assessed, control measures will be developed and implemented to ensure the risk of harm to people, the environment and equipment is reduced, and where possible, eliminated. Review of existing, or introduction of new, control measures will be undertaken if new or additional risk of accident or emergency situations occurring is identified. At intervals of no longer than two years, the IPP will test, review and update, where necessary, procedures associated with the management of risk and response to accident and emergency situations (i.e. operational control, immediate response, emergency response) to ensure continued effectiveness of the EERP. Records of the testing of the effectiveness of procedures will be produced and retained for inspection by appropriate authorities, as requested. The review of procedures associated with the management of risk and response to accident and emergency situations must include stakeholder and community engagement.

21.1.3 Types of Emergency

The scope of the EERP includes both accidents (such as fire or vehicle collisions), and natural incidents (such as sandstorms or earthquakes), and is intended to prevent injury to staff and personnel, damage to property, harm to the environment and impact upon neighboring communities.

There are a number of accident and emergency situations that have the potential to occur during operation of the Park. The IPP will ensure consideration and discussion of the types of accident and emergency situations that may potentially be encountered whilst reviewing the activities associated with construction and operation of the Park and in identification and assessment of the associated risks and hazards. Consideration will also be given to emergency situations from neighboring activities that may affect the Park and from unauthorized action/activity.

Examples of the types of accident and emergency situations that could potentially occur and the resulting impacts are provided in Table 21-1. This is not an exhaustive list and further consideration of potential accident and emergency situations will be given by the IPP during completion of the assessment of process related risks.

Table 21-1: Potential accident and emergency situations associated with operation of the Dumat Al Jandal Wind Energy Park

Accident/Emergency	Potential Impact
• Motor vehicle accidents; • Collision with light or heavy construction vehicles; • Fire and explosion; • Spillage or release of hazardous materials; • Plant or equipment failure or malfunction e.g. blade throw, falling objects etc; • Failed lifting operations; • Falls from height; • Trips and slips;	Human health impacts including: • burns; • blindness; • respiratory difficulty; • electrocution; • loss of consciousness; • trauma; and • injury.
	Environmental impacts including: • air pollution;

• Natural incidents (including flooding, sea level rise, high wind, heavy rainfall, sandstorm and earthquake); • Entrapment and crushing; • Oxygen depletion; • Heat exhaustion; • Aviation collision; • Political/local instability; and • Disease.	• soil pollution; and • water pollution. Damage to infrastructure and assets Material loss

21.2 Processes and Procedures

21.2.1 Incident/Accident Management

Following the identification of potential accident and emergency situations, the IPP will develop procedures for management of potential incidents and accidents. Control measures for identified risks will be prioritized and managed in accordance with the Risk Management Hierarchy of Controls, as set out in Figure 21-1 below.

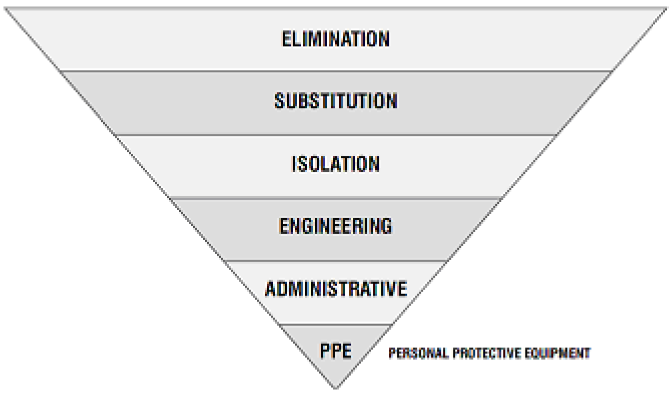

Figure 21-1: Risk Management Hierarchy of Controls

Implementation of the hierarchy of controls will ensure the final level of risk is as low as reasonably practicable (ALARP). Measures to eliminate and minimize hazards and avoid risk will be given preference in order to prevent potential emergency situations occurring. Where prevention or elimination of risk is not possible, control measures will be developed to reduce risk of an emergency situation and the associated consequences occurring, as far as possible. Procedures will be developed which will be followed in the event of an accident or emergency situation, whether this is as a result of operational control failings or natural occurrences. This will be done in consultation with stakeholders and the local community. This will include measures in response to the example situations outlined by Table 21-1 and also procedures relating to emergency shut-down of plant and equipment and other measures to prevent the potential escalation of emergency situations. Clean-up following containment, and rebuilding, if necessary, as a result of an accident or emergency situation will also be covered in the development of emergency response procedures.

21.2.2 Road Accidents

The IPP will assess the risks associated with potential accident and emergency situations that may occur either on-site or off-site as a result of motor vehicle accidents (MVA).

Road traffic levels within the vicinity of the Park will increase during the construction period of the Park, by approximately 14 vehicle movements per day (see Chapter 13: Traffic and Transport Infrastructure for further details). The parts and a substantial proportion of the other material required for construction will be transported by road, from the port of Jubail. It is likely that the parts will be transported in convoys of up to approximately 5 long and potentially slow, vehicles. It may also be necessary to transport the construction workforce to site via a bus connection.

The main transport routes into the Park from the port of Jubail are assumed to have the capacity to support this extra volume of traffic, however rates of MVA are still expected to rise during the construction phase, reflecting current trends in the Kingdom. The IPP will prepare a Logistics, Traffic and Transportation plan to minimize risk of MVA during the delivery of wind turbine components to the development site. The plan will be developed in accordance with Ministry of Transport “Exceptional Loads” 01-77 policy, dated 7-5-1432 (corresponding to 7th May 2011), which outlines the permitting requirements for transporting exceptional loads. The plan will include measures such as a requirement for all drivers to be licensed, experienced and trained through third party agencies, and for all vehicles, equipment and machinery to undergo regular maintenance with manufacturer specifications. Broader training programs should be developed and made available to the local community. Peak transport hours will be avoided to limit congestion with local commuters. Clear signage will be installed along Road 80 and King Fahd Road (for which the Park is located directly off), demarcating the site entrance with adequate space allowed for site ingress and egress. The management plan should be developed with key stakeholders (e.g. emergency services and the local community) to ensure response to MVAs can be undertaken quickly and efficiently. For further details of the management plan please see Chapter 13: Traffic & Transport Infrastructure.

Road traffic levels during the operational phase of the Park will be similar to existing levels. The IPP will prepare an operational traffic management plan which will include the requirement for Assessment of Hazard Identification and commitment to regular road safety training and defensive training for staff and operators.

21.2.3 Fire Fighting

When assessing the risks associated with the construction and operation of the Park, the IPP will also review the potential accident and emergency situations that may occur as a result of fire through identification of all potential fire hazards on-site and fire hazard characteristics that apply to fuel, raw material and waste with reference to Material Safety Data Sheets (MSDS), plant design and Occupational Safety and Health Administration (OSHA).

The IPP will address the following information requirements with regards to fire response:

- locations of fire alarm/systems/extinguishers;
- staff training in safe operation of fire extinguishers, isolation and extinguishing small fires;
- potential sources of fire;
- fire hose reel locations;
- required external support services;
- firefighting measures/instructions for each material handled on site as per MSDS; and
- emergency plant shutdown.

Requirements and methods to retain fire water and other firefighting material, such as foam and powder, to prevent discharge to drains, controlled waters or ground, will be reviewed by the IPP and added to accident and emergency procedures, where applicable.

21.2.4 Alarms and Communication

An emergency notification system and alarm will be provided on-site, which will include prompt activation of the EERP team. The IPP will communicate with appropriate authorities and stakeholders the requirements of the EERP in its development, review and implementation. A directory of all appropriate authorities and organizations, from whom support is required or who require notification in the event of an accident or emergency, will be prepared by the IPP and held in appropriate locations at the Park. This will include fire and police services and appropriate government representatives. Emergency contact details will also be included in emergency response procedures.

21.2.5 Training Practices

The IPP will assess the training needs of individual site personnel and their roles within the construction and operation of the Park, giving due consideration to the completed risk assessment and the operational control and emergency response procedures prepared. Training requirements will then be tailored to the risks and hazards of the activities associated with each phase of the Park and the potential accident and emergency situations that may be encountered. Training requirements for individuals performing specific roles in relation to accident and emergency situations will also be identified and addressed, for example, members of the EERP Team, firefighting, spill response and emergency shut-down of plant and equipment.

All site personnel will receive training that is appropriate to their role in the construction and operation of the Park, which will include and address:

- hazard identification, risk evaluation and corrective measures to address safety and environmental concerns;
- risk prevention and mitigation;
- appropriate materials handling procedures;
- special hazards specific to their job/role; and
- implementation of evacuation procedures.

All employees, regardless of their role/position at the Park, will receive an initial site induction into the safety rules of the development, which includes basic emergency response requirements and addresses the environmental issues associated with the different emergency situations that may be encountered. The IPP will also provide follow-up training to employees, as required, but in particular whenever there is a modification to the Park and/or its activities in any way.

21.2.6 Environmental Emergency Response Personnel (EERP Team)

As the development of the Park progresses, more detailed information will become available to allow the IPP to implement procedures for the selection of key site personnel who will form the EERP Team and for the development of emergency response organization (structure, authorities and responsibilities of the EERP Team) for the Park. Consideration will be given to the suitability of individuals based on their role within the operation of the Park and their ability to provide rapid and effective response to accident and emergency situations.

The names and contact details of all members of the EERP team will be listed in the emergency response directory using a format similar to that provide in Table 21-1, along with the authorities and organizations to be contacted in accident and emergency response situations.

Table 21-1: EERP Team Contact Details

Name	Position	Contact Number	Cell Phone Number

Training programs will be developed and provided to the members of the EERP Team to enable them to successfully fulfil their duties and obligations in responding to an accident or emergency situation. Training will include working jointly with external authorities or organizations, such as the fire services or government representatives, in assisting with the response to accidents and emergencies, including initial and on-going liaison with emergency services throughout an emergency situation.

21.2.7 Safety, Health and Environment (SHE)

The IPP will maintain an inventory of all chemicals and products stored/used at the Park, which will be reviewed on a quarterly basis. Hazardous materials will be labelled in accordance with the IPP Hazardous Materials Communication Program (HAZCOM) program, a Saudi Aramco example of which is shown in Figure 21-1. Material Safety Data Sheets (MSDS), Chemical Hazard Bulletins (CHBs), a construction safety manual and relevant corporate procedures will be developed and used to inform the development of operational control, emergency response and clean-up procedures, and the selection and use of personal protective clothing and equipment (PPE) appropriate to the requirements of task-specific conditions and the associated potential hazards.

The construction worker camp will be operated in accordance with the relevant IPP procedures, such as Environmental Health Codes and be compliant with IFC Performance Standard 2 – Labor and Working Conditions.

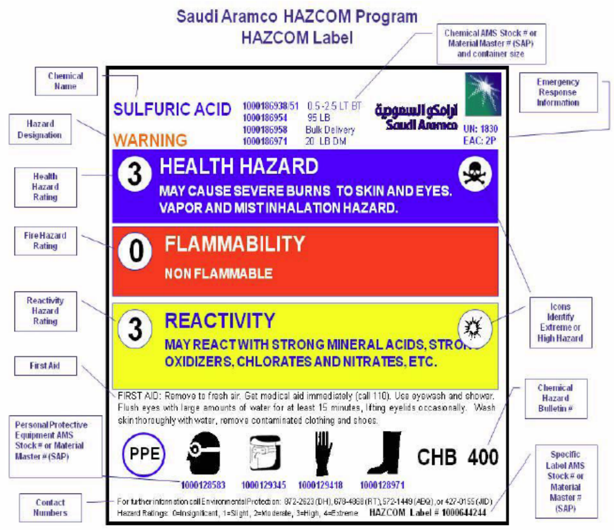

Figure 21-1: Example Hazardous Material Label

21.2.8 Immediate Response Measures

Emergency response procedures prepared by the IPP following completion of the risk assessment and identification of potential accident and emergency situations will include actions for immediate response measures, as necessary. These measures will include clear instructions to be followed by the EERP Team to respond, contain or stop the situation without delay to avoid escalation. Such measures will include actions for emergency plant and equipment shutdown, arrangements with emergency services, responding to medical emergencies and responding to equipment failure emergencies.

21.2.9 Emergency Procedures

The IPP will undertake an evaluation of all activities undertaken on site that could create an accident or emergency situation which could cause danger to life or health, impact on the environment or damage to the site, surrounding communities or industrial installations. Procedures will be prepared providing instructions to be followed in the event of accident or emergency situation occurring, wherever a risk of a potential accident or emergency has been identified following completion of the risk assessment process. Emergency procedures will be prepared in consultation with both the emergency services and employees and proposed site personnel, and other interested parties (e.g. neighboring industries), as appropriate. Stakeholders will also be consulted whenever amendments are proposed and made to the EERP during the different stages of the development of the Park.

21.2.10 Reducing Environmental impacts

There are a number of adverse environmental impacts that can potentially occur following an accident or emergency situation. Key receptors in the vicinity of the Park include the surrounding desert terrain and mountain ranges, groundwater and the local and regional atmosphere. The closest human receptors, excepting site personnel and inhabitants of the construction camp, are seasonal herder settlements, construction workers working on the nearby Gypsum Quarry and users of King Fahd Road. The nearest permanent settlement, Dumat Al Jandal, is approximately 15 km from the site boundary respectively.

The IPP will prepare and establish procedures to be implemented and followed in order to minimize environmental impacts resulting from accident or emergency situations. The procedures will include methods to ensure the containment and control of the accident or emergency situation to minimize potential environmental damage, and the necessary removal, clean-up, repair and rehabilitation measures once the situation has been contained and controlled.

Potential environmental impacts may occur as a result of any of the accident or emergency situations identified through completion of the risk assessment, and each situation, and the potential damage to each receptor, will be given full consideration by the IPP when procedures to minimize environmental impacts are developed.

Although the IPP will give due consideration in the identification of the specific actions to minimize environmental impacts in response to a specific emergency situation, there will be a number of common control measures to be considered during development of response procedures to be applied during emergency situations. Such common considerations include:

- identify other critical factors (e.g. pathways to controlled waters, ease to contain/recover material, material dispersion in air or water, consequence of different materials/substances mixing etc.);
- review MSDS and apply measures accordingly;
- where possible, isolate the source of a spill and contain the spill using suitable response equipment (e.g. absorbent material, booms, mats, etc.);
- contain fire water to prevent discharge to drains and controlled waters; and
- recover firefighting material (particularly foam or powder), especially where there is potential to discharge to controlled waters.

Waste generated as a result of response to emergency situations may have hazardous properties, which in itself poses a risk with regards to additional impacts and environmental damage occurring. The IPP will develop clear instructions for the management of hazardous waste generated from emergency response in accordance with the necessary legal requirements and relevant environmental/waste procedures applicable on site. In situations where it is evident that hazardous substances have been discharged to the environment and damage to receptors has occurred, the IPP will employ suitably qualified contractors to plan and carry out appropriate clean-up, remediation and rehabilitation works.

21.2.11 Corrective Action Plan

All accidents and emergency situations resulting in environmental impacts shall be recorded and classified in accordance with relevant IPP's procedures, to include a Notification Requirement for Incidents (including Fires) and Reports of Fire, Emergency or False Alarm.

As soon as the emergency has been contained, controlled and clean-up begins, the IPP will conduct an accident investigation and produce a report to determine the cause(s) of the incident; to provide a summary of the emergency response and success; and, to discuss lessons learned from the incident. The report will be will likely include the following information:

- circumstances of the accident (nature, timing of the event, analysis of causes, etc.);
- substances and amounts involved;
- immediate consequences and any immediate mitigation taken;
- emergency measures taken and the effectiveness of the EERP;
- proposed clean-up methods to mitigate the medium/long-term effects;
- data available to assess the effects on people and the environment; and,

- actions envisaged to prevent similar accidents.

The investigation report will also be used to recommend corrective actions to be implemented to prevent escalation or repetition of the original or similar incident(s), as necessary. Possible corrective actions for implementation may include:

- controlling the source of the pollution;
- a review of operational procedures;
- replacement of equipment;
- studies of the environmental impact upon the surrounding environment;
- management of the clean-up or repair of the area affected by the incident to prevent further release of contaminants; and,
- assessment of the need for additional operational training.

21.2.12 Materials Handled and Stored On-Site

The IPP will maintain and update at all times a register and inventory of all materials either stored and handled, or transported to and from the Park as described in section 21.2.7. The inventory will be prepared at the beginning of the construction phase, and revised on a quarterly basis thereafter (as per the IPP Construction Manual).

21.2.13 Emergency Equipment

The IPP will ensure that emergency equipment is held at key locations throughout the Park for ease of access should an emergency situation or accident occur. The location of emergency equipment and applicability for use will also be detailed in emergency response procedures, as appropriate. An inventory of all emergency equipment will be maintained and updated by the IPP at all times and regular checks and inspections of emergency equipment will take place to ensure maintenance of stock and suitability for use.

21.2.14 PPE for Emergency Personnel, First Aid and Medical Examination

The IPP will ensure that PPE and first aid boxes are held at key locations throughout the Park for ease of access should an emergency situation or accident occur. The location of PPE and applicability for use will also be detailed in emergency response procedures, as appropriate. An inventory of all PPE and first aid boxes will be maintained and updated by the IPP at all times, and regular checks and inspections of PPE and first aid boxes will take place to ensure maintenance of stock and suitability for use.

First aid and medical facilities will be provided on site during the construction period, and construction workers will have access to the Doma General Hospital Jandal, as well as the new Prince Mohammed Medical City.

21.2.15 Evacuation

The IPP will prepare appropriate evacuation procedures to be followed by construction workers and site personnel in the event of emergency situations and accidents. The type of accident or emergency will influence the evacuation procedure, including evacuation route followed, the final evacuation point, and the assembly area. Environmental factors such as wind direction will also be considered in the preparation of evacuation procedures and in determining which procedure should be followed in the event of an emergency or accident situation occurring. The IPP will ensure that all construction workers and site personnel receive sufficient training in the evacuation procedures to be followed for the different emergency situations that may be encountered whilst working at the Park.

22. Conclusion

The Dumat al Jandal Wind Energy Park will contribute towards a more balanced energy mix in the Kingdom of Saudi Arabia; and will contribute towards displacing 2,000 Thousand Barrels of Oil Equivalent (MBOE) of hydrocarbons per annum and 800 Thousand tons (Mt) of CO2 per annum from the Saudi Electricity Company power plant in Al Jouf.

This ESIA document presents the systematic assessment of potential construction, operation and decommissioning impacts. Based on the preliminary engineering design of the Park, and the stakeholder engagement and consultation that has been undertaken to date, the majority of the residual impacts are predicted to be of low to negligible significance, following the implementation of mitigation and good international industry practice (GIIP).

Notwithstanding, there are some notable residual impacts of high and moderate significance for the following environmental and social aspects: *Noise and Vibration, Landscape and Visual Impact, Traffic and Transportation*, *Waste Management* and *Health and Safety*.

The assessment of *Noise and Vibration* impacts has established that the operation of the Park could result in a noise level of above 35dba at the nearest sensitive receptors. Therefore, it is recommended that further noise modelling prediction and analysis of design options is undertaken to inform the final scheme design so as to optimize both the siting and selection of turbines. The process should be iterative such that the impact is further mitigated through the final design as far as reasonably practicable.

The assessment of Landscape and Visual Impacts identified a high significance impact associated with the view from Marid Castle. This is a precautionary rating as a change will be experienced within the view from this location however, the presence of dust and heat haze will reduce this intermittently.

Residual impacts of moderate significance have been identified under Traffic and Transportation. These impacts are principally associated with the transportation of exceptional loads (i.e. wind turbine sections, blades and nacelles) during which there are increased risks of Motor Vehicle Accidents (MVA), delays and congestion and impacts on the capacity of existing road infrastructure. This is both local to the Park and from the seaports to the development site. The residual risks of moderate significance account for the uncertainty in the proposed Logistics, Traffic and Transportation plan, which has yet to be developed. With the implementation of a fully integrated and coordinated plan which has been developed in full consultation with key stakeholders (e.g. emergency services, local Amana, Ministry of Transportation) and the affected communities, it should be possible to further reduce the significance of this impact.

During the decommissioning of the Park, a residual impact of moderate significance has been identified under *Waste Management*. During the decommissioning significant quantities of waste material will be generated, including concrete foundations, reinforced iron bars, the wind turbines and extensive lengths of cabling. At this stage of the development, the future capacity and availability of waste management infrastructure to receive these materials remains uncertain. A comprehensive decommissioning waste management plan will need to be prepared in accordance with IFC EHS Guidelines and in full consultation with the local Amana, Ministry of Municipalities and Rural Affairs, the General Authority for Meteorology and Environment (GAME) and the waste management service providers. Subject to the development of this plan, it should be possible to further reduce the significance of this impact.

The construction, operation and decommissioning of the Park present some significant challenges for managing occupational health and safety, and the safety of local communities. This will one of the fist utility scale wind energy power plants in the Kingdom of Saudi Arabia and it has reasonably been assumed that the construction workforce in the Kingdom has little experience of transporting wind turbines, operating specialist lifting equipment or understand the hazards of confined spaces working when installing or maintaining wind turbines.

To further manage the risks associated with these activities, it is recommended that the IPP develops a Permit to Work system for the development and operation of the Park. A Permit to Work system is a management system that is used to ensure that work is done safely and efficiently and establishes procedures to request, review, authorize, document and most importantly, deconflict tasks to be carried out by frontline workers. This is particularly important for high risk construction and maintenance operations (e.g. working at height, heavy lifting, confined spaces working, remote working).

The Permit to Work system should account for the unique environment of the Kingdom of Saudi Arabia, including extreme temperatures and humidity, in-Kingdom workforce attitudes and behaviors towards safety and the preservation of life, and religious practices (e.g. fasting during the month of Ramadan).

In addition to the health screening of workers for communicable disease, it is recommended that workers who perform high risk activities (i.e. working at height, confined spaces working) and operators of specialist equipment (e.g. heavy lifting equipment, vehicles carrying exceptional loads) are subject to regular medical and fitness checks.

A primary concern during the development of a wind energy power plant is the risk of mortality or injury to birds colliding with the wind turbine infrastructure, particularly the rotor blades. Migratory surveys were completed during spring and autumn 2017, supplemented by winter and breeding surveys. Collision risk modelling has been undertaken and no significant impacts are predicted.

The commencement of stakeholder consultation for the Park was later than anticipated, and began following official approval from the Ministry of Energy, Industry and Mineral Resources (MEIM). Representatives of the Government ministries attended a workshop in Riyadh on 22nd May 2017 during which the project details were disclosed, and the scope of the assessment was openly discussed. At this stage of the project, the Government Ministries have expressed their support for the project and no objections have been raised.

The IPP must continue to engage and consult with the Government Ministries during the next phases of development, and must additionally commence consultation with the local community and potentially vulnerable groups in accordance with the project Stakeholder Engagement Plan. This includes continued consultation with the stakeholders identified in the Radar Assessment Report (Appendix K) and the further analysis of impact on radar and telecommunications infrastructure.

The findings of the ESIA should be reviewed following more extensive public stakeholder consultation, and once the design of the new power plant has been further developed. If required, an Addendum to this ESIA will be prepared by the IPP, in consultation with project stakeholders.

23. Abbreviations and Acronyms

Acronym	Description
A.C	Alternating Current
ACES	Arab Company for Laboratories and Soils
ALARP	As Low as Reasonably Practicable
ASTM	American Society for Testing Materials
ATC	Automated Traffic Counts
AWEA	American Wind Energy Association
BAT	Best Available Techniques
BCT	Bat Conservation Trust
BPM	Best Practicable Means
BREF	Best Available Techniques Reference Documents
BS	British Standard
BWEA	British Wind Energy Association
CEMP	Construction Environmental Management Plan
CIEEM	Chartered Institute of Ecology and Environmental Management
CITES	Convention on International Trade of Species
CER	Certified Emission Reductions
CN	Curve Number
CRM	Collision Risk Modelling
CSP	Concentrated Solar Power Technologies
CTW	Central treatment Works
CWMP	Construction Site Waste Management Plan
D.C	Direct Current
dB	Decibels
DECC	Department of Energy and Climate Change
DHI	Daily Heat Index
DMP	Dust Management Plan
EBRD	European Bank for Reconstruction and Development
EERP	Emergency Response Plan
EHS	World Bank Group Environmental, Health, and Safety Guidelines
EMMP	Environmental Monitoring Management Plan
EPA	Environmental Protection Agency
EPC	Engineering Procurement and Construction
EPD	Saudi Aramco Environmental Protection Department
EPFI	Equator Principles Financial Institutions
Eps	Equator Principles
EBRD	European Bank for Reconstruction and Development
EPFI	Equator Principles Financial Institutions
ESD	Emergency Shutdown
ESF	World Bank's Environmental and Social Framework
ESIA	Environmental and Social Impact Assessment
ESMS	Environmental and Social Management System
ESMP	Environmental and Social Management Plan
FAO	Food and Agriculture Organization of the United Nations
FPD	Saudi Aramco Facilities Planning Department
FRP	Fiber Reinforced Polymers
GACA	General Authority of Civil Aviation
GAME	General Authority for Meteorology and Environment
GCC	Gulf Cooperating Countries
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEMS	Global Environmental Management Services
GERRI	General Environmental Regulations Rules for Implementation

GHG	Greenhouse Gas
GHI	Global Horizontal Irradiation
GIIP	Good International Industry Practice
GW	Giga-Watt
GWh	Giga-Watt Hours
GOD	Groundwater Overall Depth Classification
GOSI	General Organization for Social Insurance
GOSP	Gas Oil Separation Plant
HAZCOM	Hazardous Materials Communication
HPSV	High Pressure Sodium Vapor
HVAC	Heating, Ventilation and Air-Conditioning
IAQM	Institute of Air Quality Management
IBA	Important Bird and Biodiversity Area
IBRC	International Bird Research Centre
ICAO	International Civil Aviation Organization
ICC	International Computer Company
ICH	Intangible Cultural Heritage
ICOMOS	The International Council on Monuments and Sites
ID	Identification Code
IED	Industrial Emissions Directive
IFC	International Finance Corporation
IFI/MFI	International/Multilateral Financial Institutions
IPA	Important Plant Area
IPP	Independent Power Project
ISO	International Organization for Standardization
ITS	Invertor–Transformer Stations
IUCN	Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
JWPC	Jordan Wind Project Company
KACARE	King Abdullah City for Atomic and Renewable Energy
KPI	Key Performance Indicator
LCT	Landscape Character Types
LOS	Level of Service
LP or SP L	Sound Pressure Level
LUP	Land Use Permit
LV AUX	Low Voltage Auxiliary
LVIA	Landscape and Visual Impact Assessment
MBGL	Meters Below Ground Level
MBOE	Thousand Barrels of Oil Equivalent
MCM	Million Cubic Meters
MDG	Millennium Development Goals
MEIM	Ministry of Energy, Industry and Mineral Resources
MENA	Middle East and North Africa
MFI-WG	The MFI Working Group on the Environment
MBOE	Thousand Barrels of Oil Equivalent
MEWA	Ministry of Environment Water and Agriculture
MMBOE	Million Barrels of Oil Equivalent
MMscfd	Million Standard Cubic Feet per day
MODON	The Saudi Industrial Property Authority
MOE	Ministry of Education
MOH	Ministry of Health
MOMRA	Ministry of Municipalities and Rural Affairs
MOT	The Ministry of Transport
MOU	Memorandum of Understanding
MSB	Migratory Soaring Birds
MSDS	Material Safety Data Sheet
Mt	Thousand Tons

$MtCO_2e$	Thousand Tons CO_2 Equivalent
MVA	Motor Vehicle Accidents
MV/HV	Medium Voltage/High Voltage
MW	Mega Watt
MWE	Ministry of Water and Electricity
NASA	The US National Aeronautics and Space Administration
NCD	Non-communicable Disease
NCWCD	National Commission for the Conservation of Wildlife and Development
NDP	National Development Plan
NGO	Non-Governmental Organization
NOx	Nitrogen
NREP	National Renewable Energy Program
NWC	National Water Company
OHB	Occupational Hazards Branch
OUV	Outstanding Universal Value
OP/BP	Operations Policy/Bank Procedure
OPEC	Organization of Petroleum Exporting Countries
OSHA	Occupational Safety and Health Administration
Pa	Pascals
PEL	Public Environment Law 2011
PIF	Public Investment Fund
PM_{10}	Particulate Matter
PME	The Presidency of Meteorology & Environment
PMEES	GAME Environmental Standard
PPV	Peak Particle Velocity
PO4-P	Phosphorus
PSRD	(Saudi Aramco) Power Systems Renewables Department
PV	Photovoltaic
Qdc	Sand and Gravel Deposits
RC	Royal Commission
REC	Percentage Recovery
REPDO	Renewable Energy Project Development Office
RQD	Rock Quality Designation
RTU	Remote Terminal Unit
SAMA	Saudi Arabian Monetary Agency
SAMIRAD	Saudi Arabia Market Information Resource and Directory
SAPTCO	Saudi Public Transport Company
SAR	Saudi Railway Company
SASO	Saudi Standards, Meteorology and Quality Organization
SCADA	Supervisory Control and Data Acquisition
SCS	Soil Conservation Service
SCTA	Saudi Commission for Tourism and National Heritage
SDSN	United Nations Sustainable Development Solutions Network
SEC	Saudi Electricity Company
SEP	Stakeholder Engagement Plan
SHE	Safety Health and Environment
SIMP	Social Impact Management Plan
SLM	Sound Level Meter
SLR	Single Lens Reflex
SMBC	Sumitomo Mitsui Banking Corporation
SMSE	The Surface Meteorology and Solar Energy
SNH	Scottish Natural Heritage
SPA	The Saudi Ports Authority
SRO	The Saudi Railways Organization
STC	Saudi Telecommunications Company
SWA	Saudi Wildlife Authority
SWCC	Saline Water Conversion Company

TCS	Turbine Control System
TMC	Turning movement Counts
TMY	Typical Meteorological Year
TRRL	Transport and Road Research Laboratory
TSE	Treated Sewage Effluent
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	UN Framework Convention on Climatic Change
UNWECD	United Nations World Commission on Environment and Development
UPS	Uninterrupted Power Supply
VAT	Value Added Tax
VMS	Vibration Monitoring System
VOC	Volatile Organic Compounds
VP	Vantage Point
WHO	World Health Organization
WTG	Wind Turbine Generator
WTO	World Trade Organization
ZTV	Zone of Theoretical Visibility

Appendix A. Air Quality Assessment

In the absence of guidance on construction dust impacts specific to the Kingdom of Saudi Arabia or the United States, the assessment of dust during construction has been carried out using a qualitative risk-based appraisal with reference to the sites location in relation to sensitive locations, the planned activities and site characteristics, as described by the IAQM guidance.

Although the guidance is aimed at the UK, it is recognized within the document that this guidance may be applied elsewhere, as long as careful consideration is given as to the applicability where different climates and where working practices on construction sites are different. For this project, the use of standard construction equipment and mitigation practices as likely to be found in the UK suggests that the methodology can be used here. In addition, similar air quality standards apply in both countries, so the implied effects within the qualitative methodology will be similar. The main difference is likely to be the composition of the dust, with the dust in this instance being mainly derived from large-grained sandy material as compared to the more silt-based sedimentary material likely to occur at sites in the UK. This means that the fraction of the sandy dust here that is small enough to enter the body through the nose and/or mouth during breathing (i.e. the respirable fraction) will be less than the respirable fraction of the more silty dust in the UK. Therefore, this will tend to result in the assessment for this project being more conservative.

The methodology for the assessment of the construction impacts is based on a five-step approach as set out in Figure A23-1.

Note that in this appendix the assessment levels are consistent with the IAQM document. However, for this assessment, the methodology uses a level of ‘Moderate’ (see Chapter 5), which is equivalent to a level of ‘Medium’ in the IAQM method.

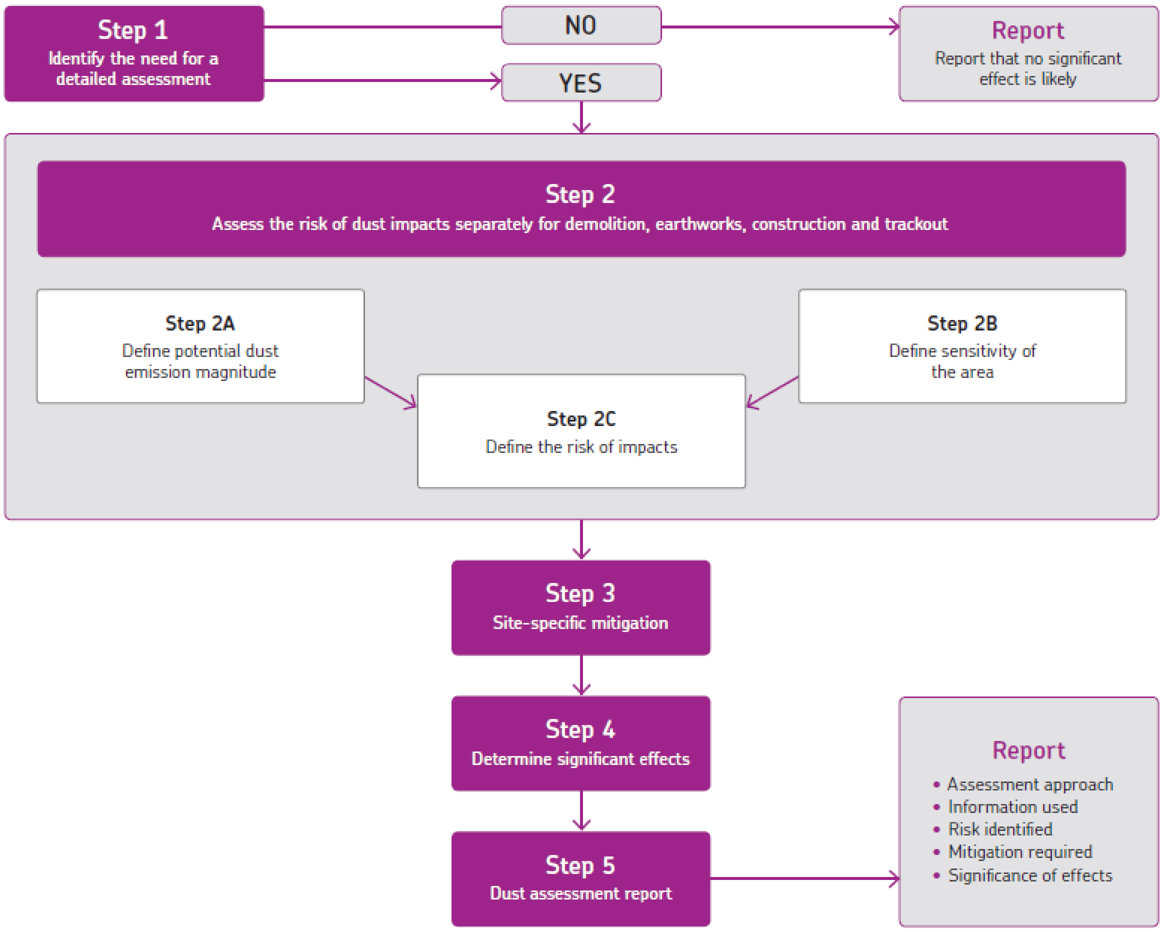

Figure A23-1 Structure of construction dust assessment

A.1 Identify the need for a detailed assessment

An assessment will be required where there is:

- a human receptor within 350 m of the Park site boundary and/or within 50 m of the access route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s); and/or
- an ecological receptor within 50 m of the Park site boundary and/or within 50 m of the access route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).
    - The requirement for a dust risk assessment can be screened out where the criteria are met, as it can be concluded that the level of risk is Negligible and any effects would be 'not significant'. If there are human or ecological receptors within the distance criteria set out in Step 1, Steps 2 to 4 should be undertaken as shown in Section A.2.

A.2 Assess the risk of dust impacts

A.2.1 Step 1: Define the potential dust emission magnitude

Demolition

The following are descriptors for the different dust emission magnitudes for demolition:

Large: total building volume greater than 50,000 m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening demolition activities greater than 20 m above ground level;

Medium: total building volume 20,000 m^3 to 50,000 m^3, potentially dusty construction material, demolition activities 10 m to 20 m above ground level; and,

Small: total building volume less than 20,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities less than 10m above ground, demolition during wetter months.

Earthworks

The following are descriptors for the different dust emission magnitudes for earthworks:

Large: total site area greater than 10,000 m^2, potentially dusty soil type (e.g. clay, which would be prone to suspension when dry due to small particle size), greater than 10 heavy earth moving vehicles active at any one time, formation of bunds greater than 8 m in height, total material moved greater than 100,000 tonnes;

Medium: total site area 2,500 m^2 to 10,000 m^2, moderately dusty soil type (e.g. silt), 5 to10 heavy earth moving vehicles active at any one time, formation of bunds 4 m to 8 m in height, total material moved 20,000 tonnes to 100,000 tonnes; and

Small: total site area less than 2,500 m^2, soil type with large grain size (e.g. sand), less than 5 heavy earth moving vehicles active at any one time, formation of bunds less than 4 m in height, total material moved less than 10,000 tonnes, earthworks during wetter months.

Construction

The following are descriptors for the different dust emission magnitudes for construction:

Large: total building volume greater than 100,000 m^3, piling, on-site concrete batching, sandblasting;

Medium: total building volume 25,000 m^3 to 100,000 m^3, potentially dusty construction material (e.g. concrete), piling, on-site concrete batching; and,

Small: total building volume less than 25,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber).

Trackout

Trackout refers to the transport of dust and dirt from the site area onto the public road network, where it may be deposited and re-suspended by other vehicles using the road network. Only receptors within 50 m of the route(s) used by vehicles on the public highway up to 500 m from the Park entrance are considered to be at risk.

The following are descriptors for the different dust emission magnitudes for trackout:

Large: greater than 50 HGV outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length greater than 10 0m;

Medium: 10 to 50 HGV outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 m to 100 m; and

Small: less than 10 HGV outward movements in any one day, surface material with low potential for dust release, unpaved road length less than 50 m.

Define the sensitivity of the area

The sensitivity of the area takes account of a number of factors:

- the specific sensitivities of receptors in the area;
- the proximity and number of those receptors;
- the local background PM_{10} concentrations; and,
- site-specific factors.

For this assessment of the sensitivities of people to dust soiling effects and to the health effects of PM_{10}, the receptors will be identified as ‘High’, ‘Medium’ or ‘Low’ sensitivity based on the criteria described in the IAQM guidance (IAQM, 2014). Table A23-1 presents indicative examples of classification groups for the varying sensitivities of people to dust soiling effects and to the health effects of PM_{10}. A judgement is made at the site-specific level where sensitivities may be higher or lower.

Table A23-1: Indicative examples of the sensitivity of different types of receptors

Sensitivity of receptor	Sensitivities of people and ecological receptors	
	Dust soiling effects [1]	Health effects of PM_{10} [2]
High	Dwellings, museums and other culturally important collections, medium and long-term car parks and car showrooms.	Residential properties, hospitals, schools and residential care homes.
Medium	Parks, places of work.	Office and shop workers not occupationally exposed to PM_{10}.
Low	Playing fields, farmland, footpaths, short-term car parks and roads.	Public footpaths, playing fields, parks and shopping streets.

1 People’s expectations would vary depending on the existing dust deposition in the area.
2 This follows the Department for Environment, Food and Rural Affairs (Defra, 2016) guidance as set out in Local Air Quality Management Technical Guidance (LAQM.TG (16)). Notwithstanding the fact that the air quality objectives and limit values do not apply to people in the workplace, such people can be affected to exposure of PM_{10}. However, they are considered to be less sensitive than the general public as a whole because those most sensitive to the effects of air pollution, such as young children are not normally workers. For this reason workers have been included in the medium sensitivity category.

Table A23-2 and Table A23-3 set out the selection criteria for the sensitivity of the area to dust soiling effects on people and property, and the selection criteria for the sensitivity of the area to human health impacts, respectively.

Table A23-2: Criteria for the sensitivity of the surrounding area to dust soiling effects on people and property

Receptor sensitivity	Number of receptors	Distance from the source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10 – 100	High	Medium	Low	Low
	1 – 10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Table A23-3: Criteria for the sensitivity of the surrounding area to human health

Receptor sensitivity	Annual mean PM_{10} concentration	Number of receptors	Distance from the source (m)				
			<20	<50	<100	<200	<350
High	> 64µg/m^3	>100	High	High	High	Medium	Low
		10 – 100	High	High	Medium	Low	Low
		1 – 10	High	Medium	Low	Low	Low
	56 – 64µg/m^3	>100	High	High	Medium	Low	Low
		10 – 100	High	Medium	Low	Low	Low
		1 – 10	High	Medium	Low	Low	Low
	48 – 56µg/m^3	>100	High	Medium	Low	Low	Low
		10 – 100	High	Medium	Low	Low	Low
		1 – 10	Medium	Low	Low	Low	Low
	< 48µg/m^3	>100	Medium	Low	Low	Low	Low
		10 – 100	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
Medium	> 64µg/m^3	>10	High	Medium	Low	Low	Low
		1 – 10	Medium	Low	Low	Low	Low
	56 – 64µg/m^3	>10	Medium	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
	48 – 56µg/m^3	>10	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
	< 48µg/m^3	>10	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
Low	n/a	>1	Low	Low	Low	Low	Low

A.2.2 Step 2: Define the risk of impacts

The dust emission magnitude is then combined with the sensitivity of the area to determine the overall risk of impacts with no mitigation measures applied. The matrices in Table A23-4 provide a method of assigning the level of risk for each activity. These can then be used to determine the level of mitigation that is required.

Table A23-4: Determination of risk of dust impacts

Sensitivity	Dust emission magnitude		
	Large	Medium	Small
	Demolition		
High	High risk	Medium risk	Medium risk
Medium	High risk	Medium risk	Low risk
Low	Medium risk	Low risk	Negligible risk
	Earthworks		
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible risk
	Construction		
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible risk
	Trackout		
High	High risk	Medium risk	Low risk
Medium	Medium risk	Low risk	Negligible risk
Low	Low risk	Low risk	Negligible risk

A.2.3 Step 3: Site specific mitigation

During the construction phase, it would be important to control dust levels for High, Medium and Low risk sources. In order to avoid significant impacts from dust during the construction phase, suitable mitigation measures should be adopted. Following the identification of the risk category for the demolition, earthworks, construction and trackout activities based on Table A23-3 to Table A23-4, appropriate mitigation measures can be identified. Activities identified as a High risk will require a greater level of mitigation than those identified as Low risk.

A selection of these measures have been specified for Low risk to High risk sites in the IAQM guidance (IAQM, 2014) as measures suitable to mitigate dust emissions from activities, such as those which form part of the Park.

A.2.4 Step 4 Determine significant effects

Following Step 2 (definition of the Park and the surroundings and identification of the risk of dust effects occurring for each activity) and Step 3 (identification of appropriate site-specific mitigation), the significance of the potential dust effects can be determined. The recommended mitigation measures should normally be sufficient to reduce construction dust impacts to a not significant effect.

The approach in Step 4 of IAQM dust assessment guidance has been adopted to determine the significance of effects with regard to dust emissions. The guidance states:

"For almost all construction activity, the aim should be to prevent significant effects on receptors through the use of effective mitigation. Experience shows that this is normally possible. Hence the residual effect will normally be 'not significant."

IAQM guidance also states that:

"Even with a rigorous DMP [Dust Management Plan] in place, it is not possible to guarantee that the dust mitigation measures will be effective all the time, and if, for example, dust emissions occur under adverse weather

conditions, or there is an interruption to the water supply used for dust suppression, the local community may experience occasional, short-term dust annoyance. The likely scale of this would not normally be considered sufficient to change the conclusion that with mitigation the effects will be 'not significant'."

Step 4 of IAQM guidance recognizes that the key to the above approach is that it assumes that the regulators, ensure that the proposed mitigation measures are implemented. The management plan would include the necessary systems and procedures to facilitate on-going checking by the regulators to ensure that mitigation is being delivered, and that it is effective in reducing any residual effect to 'not significant' in line with the guidance. It is also noted that the mitigation measures identified in the IAQM guidance includes those set out in Chapter 4 of the IFC Environmental, Health and Safety (EHS) Guidelines: Construction and Decommissioning.

A.2.5 Greenhouse Gas Emissions

The GHG emissions have been evaluated based on CO_2 equivalent and estimated based on fuel consumption. The emission sources considered comprise of:

- Scope 1 Direct emissions sources
- * Scope 3 Other indirect /value chain emissions (i.e. waste disposal and staff travel)

Due to the minimal consumption of purchased electricity, Scope 2 – Indirect Emissions has not been included in the assessment.

As described in Chapter 2, it is a requirement of the Equator Principles that projects assess their Scope 1 (direct emission sources (i.e. direct emissions from activities on site or directly associated with the operation)) and 2 (indirect emission) carbon emissions. Those projects emitting more than 100,000 metric tonnes of CO_2 annually during operations are required to undertake an alternatives analysis. The method of calculation of the project's operational carbon is based on the GHG Protocol, assessed in accordance with the Royal Commission Environmental Regulations (RCER) 2015 Environmental Permit Program and the Saudi Aramco Engineering Procedures 13 (SAEP-13) and guidance from the UK Government's Department of Energy and Climate Change (DECC, 2009). The process involves:

- identifying the activities/processes which release GHG,
- categorization of the activities by scope, and
- quantification of the emissions.

For the purpose of this calculation the sources of Scope 1 and 2 GHG include CO_2 emissions associated with the following elements of the project:

- emissions from fuel used during transport of construction materials, cables and turbine components to the Park;
- emissions from fuel used by the plant and equipment required for the construction, operation and decommissioning phase; and
- emissions during production of the raw materials used for the construction of the Park, such as steel, copper and concrete.

A.2.6 Transport

The information on the number of heavy duty vehicles (HDVs) required for the construction of the Park were reviewed. This includes the shipping of the turbine components from China and Europe and the transport of all other materials from suppliers in the region of the Park. The total distance travelled by HDVs was calculated and converted to CO_2 using a factor of 1.134 kg CO_2e/km from the UK Government GHG Conversion Factors based on a 100% laden articulated lorry (>33 tonne). For shipping emissions, an emissions factor, also from the UK Government, of 0.016 kg CO_2e/tonne.km has been used to calculate the CO_2 emissions.

A.2.7 Plant and machinery

From the equipment list provided, the power rating (in kWh) of each plant was determined and the total power consumption calculated throughout the construction, operation and decommissioning. Then on the basis that the fuel used would be diesel, a conversion factor of 0.268 kg CO_2e/kWh (UK Government GHG Conversion Factors) was used to calculate the total CO_2 emissions from the plant and machinery used for the Park.

A.2.8 Materials

The final calculation was to determine the CO_2 emissions associated with the production of the raw materials used to construct the Park. The four main materials used and the associated CO_2 emission factor are provided below:

- asphalt (for the perimeter road and the internal roads) – 0.086 t CO_2 / t asphalt;
- concrete (for turbine foundations,) - 0.083 t CO_2 / t concrete;
- copper (for cabling) – 2.71 t CO_2 / t copper (tube and sheet); and
- steel (for framework) – 1.66 t CO_2 / t steel (plate, average recycled content).

Appendix B. Sound Level Meter Calibration Certificate

CERTIFICATE OF CALIBRATION

ISSUED BY AV CALIBRATION

Date of issue 22/5/1/5 Certificate N° 1505286

AV Calibration
2 Warren Court
Chicksands, Shefford
Bedfordshire SG17 5QB
U.K.
Tel: +44 (0)1462 638600
Fax: +44 (0)1462 638601
Email: lab@avcalib.co.uk
www.avcalibration.co.uk
Acoustics Noise and Vibration Ltd trading as AV Calibration

Page 1 of 4 Pages	
Signed	
G. Parry [ ]	B. Baker [✓]

CLIENT	Jacobs Ltd Enviros House Shrewsbury Business Park Sitka Drive Shrewsbury SY2 6LG
F.A.O.	Barry Salway
ORDER No	-
Job No	TRAC15/05127/03
DATE OF RECEIPT	12 May 2015
PROCEDURE	AV Calibration Engineer's Handbook section 3
IDENTIFICATION	(0873) Sound level meter Rion type NL-32 serial No 00482601 connected via extension lead type EC-04 and preamplifier type NH-21 serial No 27705 to a half-inch microphone type UC-53A serial No 321276 fitted with a foam windshield type WS-03. Associated calibrator Rion type NC-74 serial No 34257024 with a one-inch housing and adapter type NC-74-002 for half-inch microphone.
CALIBRATED ON	22/5/1/5
PREVIOUS CALIBRATION	Calibrated on 17 March 2014, Certificate No. TCRT14/1093 issued by a non accredited calibration laboratory ANV Measurement Systems

CERTIFICATE OF CALIBRATION

ISSUED BY AV CALIBRATION

Certificate N°	1505286
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The sound level meter was set to frequency weighting A and adjusted to read 93.6 dB (corresponding to 93.6 dB at standard atmospheric pressure) in response to the sound calibrator supplied. This reading was derived from the Calibration Certificate No. 1505280 supplied by this laboratory and manufacturers' information on the free-field response of the sound level meter when fitted with the windshield.

The sound level meter was then tested, and its overall sensitivity adjusted as required.

An acoustic calibration at 1kHz was performed by application of a standard sound calibrator, whilst the tests at 125Hz and 8kHz were performed by the electrostatic actuator method.

At the end of the test, the sound calibrator was reapplied to the sound level meter and the meter reading was recorded.

RESULTS

The sound level meter was found to conform to the type 1 requirements of BS EN 60651:1994* and BS EN 60804:1994* for those tests carried out.

The self-generated noise recorded was:

9.3 dB (A) 15.5 dB (C) 22.2 dB (Lin)

The sound level meter reading obtained at the end of the test in response to the sound calibrator was 93.6 dB (corresponding to 93.6 dB at standard atmospheric pressure). This reading, corrected for ambient pressure, should be used henceforth to set up the sound level meter for field use.

The expanded level uncertainty of the Laboratory's 1 kHz sound calibrator used during this verification is ± 0.22 dB; that of the calibrator supplied with the sound level meter is ± 0.23 dB.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with the *Guide to the Expression of Uncertainty in Measurement* published by the International Organisation for Standards (ISO).

All measurement data are held at AV Calibration for a period of at least six years.

The case reflection factors have been taken as zero, since an extension lead has been used for this verification.

The reference range, linearity range and primary indicator range specified by the manufacturer have been used. *See note 5 Below.*

The Rion NL-32 sound level meter design has successfully undergone pattern evaluation at Physikalisch-Technische Bundesanstalt (PTB). It was found to meet the requirements of BS EN 60651* and BS EN 60804* and was granted pattern approval as a Type 1 sound level meter.

No component of uncertainty for manufacturer-specified corrections has been included in the uncertainty budget and, in accordance with amendments to the standards, the measured values obtained during the verification have not been extended by any measurement uncertainty when assessing conformance to each standard.

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NOTES

*1 BS EN 60651:1994 and BS EN 60804:1994 were formerly numbered BS 5969:1981 and BS 6698:1986 respectively.

2 No suitable microphone frequency response information was supplied with the instrument. It was therefore measured by this laboratory using the electrostatic actuator method.

3 The instrument was tested with integral software as received.

4 The NL-32 does not have a "max hold" function available when operating with time weighting I. The results recorded for the test of time weighting I are therefore the highest instantaneous reading shown on the display. Whilst these results meet the requirements of the standard, those for response to a single tone burst in particular may give a misleading impression of the accuracy of time weighting I on this instrument.

5 After consultation with the manufacturer and their European agents, it has been established that the specifications given in the standard English-language handbook for the NL-32 are both incomplete and incorrect. An addendum to the handbook based on the PTB tests has been provided by Rion, and this revised specification has been used for the purposes of the present verification. For information, extracts from the addendum have been appended as page 4 of this certificate.

6 The instrument was labelled "Aspinwall 00873" and "SKM GB-A03515"

7 The combination of microphone response and WS-03 windshield corrections was causing a FAIL result at 8kHz - instrument fitted with new replacement UC-53A microphone for this verification.

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The following data supplied by Rion are included for completeness:

Addendum to the NL-32 Instruction Manual

Errata (page 133):

- Total range: 23 to 137 dB(A).
- Linearity range (on 30 - 120 dB reference range): 99 dB (28 to 127).

Additional information

- Primary indicator range (on 30 - 120 dB reference range): 32 - 111 dB, allowing a crest factor of 10 for Impulse time weighting.
- Pulse range: > 63 dB
- Measurement range for various LEVEL settings: See table below.

Measurement ranges

Measurement range for various "LEVEL" range settings (dB) *
Frequency weighting A-, C- and Lin.

"LEVEL" Setting (dB)	Time weighting			Leq
	Fast/Slow	Impulse	Peak	
20 - 80	23 - 80 **	23 - 70 **	50 - 90	23 - 87 **
20 - 90	23 - 90 **	23 - 80 **	50 - 100	23 - 97 **
20 - 100	23 - 100 **	23 - 90 **	50 - 110	23 - 107 **
20 - 110	23 - 110 **	23 - 100 **	50 - 120	23 - 117 **
30 - 120	28 - 120 **	28 - 110 **	50 - 130	28 - 127 **
40 - 130	38 - 130	38 - 120	50 - 140	38 - 137

* For time weighting Fast and Slow a crest factor 3, and for time weighting Impulse a crest factor 10, is taken into account.
** The lower limit of the measurement range is 30 dB(C) for C-weighting and 35 dB(Lin) for Lin weighting.

END

Appendix C. Construction and decommissioning activities and sound power levels

Noise modelling scenario/ activity	Octave Band Center Frequency Sound Power Level (L_{Zeq}), Hz								
	63	125	250	500	1k	2k	4k	8k	dBA
Installation of access roads	127.0	127.3	120.3	118.9	119.5	115.0	110.6	104.8	**123.3**
Site grading	121.3	120.9	116.5	123.1	116.7	111.3	107.6	101.1	**122.5**
Install construction compound	108.3	109.1	106.7	124.8	104.1	103.6	97.0	93.9	**121.8**
Installation of fencing & lighting	120.2	124.0	116.4	117.9	114.4	111.8	106.8	103.3	**119.9**
Install foundations for turbines 1)	130.2	127.0	123.9	122.0	123.2	120.8	114.7	107.8	**127.3**
Installing turbines	112.8	111.8	105.8	106.8	105.8	105.8	96.8	87.8	**111.0**
Installing cabling 1)	131.8	126.6	119.1	124.7	114.7	113.2	113.8	106.1	**124.1**
Power supply at construction site 1)	106.0	103.0	107.0	101.0	100.0	96.0	87.0	78.0	**104.7**
Concrete batching plant 1)	104.0	100.7	97.3	112.5	104.0	98.7	93.1	87.6	**110.9**
Uninstall turbines 1)	124.6	123.2	128.2	128.1	129.1	127.1	124.0	128.0	**134.3**
Breaking and removal of concrete	133.9	130.5	128.5	126.4	127.2	130.3	126.4	125.2	**134.9**

Table B 1: Sound power levels of construction and decommissioning activities

1) Included in noise modelling exercise.

Appendix D. Heavy vehicle movements on access roads to and from site

Noise source	Octave Band Center Frequency L_{Zmax} Noise Level, Hz								
	63	125	250	500	1k	2k	4k	8k	dBA
Dump truck (empty)	114	107	107	107	107	112	97	88	**115**

Table C 1: Lzmax pass by noise level of lorry used in the assessment of vehicle noise impacts

Heavy vehicles movements		Assumed average speed (kmph)
TOTAL per day	Assumed hourly average	
16	4	50

Table C 2: Construction road traffic flows and speeds

Appendix E. Wind turbine noise source data

The following noise source data has been used within the assessment of operational noise effects resulting from noise radiated from the proposed wind turbines.

The Dumat Terms of Reference report (SA217900-02-G-REP-2006, Rev.0) states the following:

"*The Park consists of a wind power plant, including up to 132 wind turbine generators (WTGs) with a maximum height of up to 175 meters (m), and an associated grid interconnection. including a medium voltage/high voltage (MV/HV) sub-station and HV overhead lines connecting the sub-station to the electrical transmission system owned by the Saudi Electricity Company (SEC)"*

"At this stage of the design, the turbine manufacturer and turbine specification have not been identified. However a generic turbine model with a rated power of up to 3.5 MW and a rotor diameter of up to 130m has been assumed (DNV GL, 2017)."

Following the design change to increase the height of the turbines, this has been interpreted as maximum figures of:

- No. of turbines: 132
- Total height of turbine: 225 m
- Rotor blade length: 70 m
- Hub height: 155 m
- Power output: 3.5 MW

The General Electric (GE) 3.8 MW turbine (3.8-130) has been selected as a candidate wind turbine for the assessment. The turbine has a quoted sound power level of 106.5 dBA under normal operation, with reduced noise modes available (GE, 2016). Spectral data for the candidate turbine has not been identified, and the 'normal operation' condition quoted within the literature is not described in detail, however for the purposes of this assessment it is assumed to be representative on noise emissions at a wind speed on 10 m/s.

The spectral data for the turbine was obtained following a review of literature available online. Three candidate turbines were identified, these being Vestas V90 3 MW, Siemens SWT-2.3-93 (2.3 MW) and Siemens 3.6 MW (90 m hub height). The quoted sound power levels (L_{WA}) for the turbines varied between 105 to 109 dB, at wind speeds of 8 to 10 m/s. The spectral corrections for each of the turbines were tested within the initial modelling exercise and the spectrum that generated the highest predicted noise levels at the worst affected receptors, Siemens SWT-2.3-93, was adopted for the subsequent assessment.

Table D 1 presents the noise data used within the noise assessment.

Wind Turbine	Octave Band Center Frequency Sound Power Level (L_{Aeq}), Hz								
	63	125	250	500	1k	2k	4k	8k	dBA
General Electric 3.8-130	*	*	*	*	*	*	*	*	**106.5**
Candidate spectral data correction for Siemens SWT-2.3-93 (Corriemoillie Wind Farm Environmental Statement: Chapter 11 - Noise, 2010)	-20.8	-11.8	-5.1	-4.7	-7.6	-11.1	-16.4	-20.1	**0**

Wind Turbine	Octave Band Center Frequency Sound Power Level (L_{Aeq}), Hz								
	63	125	250	500	1k	2k	4k	8k	dBA
GE 3.8-130 with spectral data corrections applied (*as used in noise modelling assessment*)	85.7	94.7	101.4	101.8	98.9	95.4	90.1	86.4	**106.5**

Table D 1: Sound power levels of candidate wind turbine

* Octave band data unavailable.

Appendix F. Full Ornithological Baseline Report

Dumat al Jandal Wind Energy Park

Saudi Aramco

Phase 3: Baseline Ornithology Survey Report

SA217900-03-G-REP-3006 | 0

November 2017

Dumat al Jandal Wind Energy Park

Project No: SA217900
Document Title: Phase 3: Baseline Ornithology Survey Report
Document No.: SA217900-03-G-REP-3006
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Client Name: Saudi Aramco
Client No: 132475
Project Manager: Michael Robinson
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0	26/11/2017	Issued for Client Review	Calum Campbell	Matt Hobbs/ Phil Shepherd	Michael Robinson / Eddie Bradbrook

JACOBS ZATE

Contents

1. Introduction

The proposed Dumat al Jandal Wind Energy Park lies in the north of the Kingdom of Saudi Arabia (KSA) within Al Jouf Province. The centre of the site is approximately 20 km north of the town of Dumat al Jandal and approximately 35 km west of the provincial capital of Sakaka. The site location and boundary, hereafter referred to as the development site, are shown in Figure GE03.

The proposed development consists of a wind power plant, including up to 132 wind turbine generators with a maximum height of up to 225 m (i.e. 155 m hub height and 140 m rotor diameter), and an associated grid interconnection, including two sub-stations located within the development site. The turbines will be connected to the sub-stations with underground cabling along pre-defined access tracks which will remain in-situ for the 25-year lifetime of the development.

The development site lies on a raised plateau at an altitude of between 700 m and 800 m above sea level (asl). The majority of the desert plateau is characterised by bare rock. Small, seasonally inundated, patches of vegetative growth are sparsely distributed across the development site and heavily grazed by livestock. The south-east of the site is used recreationally by local residents and a number of semi-permanent Bedouin-style shelters are located in this area.

The plateau is located adjacent to an industrial railway line which runs approximately north to south along the western edge of the development site. There is a single bridge over the railway line which allows access to the site from the west. The surrounding landscape to the north, east and south is 100-200 m below the height of the development site. The edges of the plateau are typically characterised by large steep boulder scree slopes with little to no vegetation cover. There is a working sand and gravel quarry east of the development site and scattered farmland with nomadic livestock use to the south.

The plateau ends at sheer cliff edges along some sections of its northern edge with a large (c.30 km^2) basin located at the foot of the cliffs and beyond the boundary of the development site. This basin is the most significant geographical feature in the area. It extends 12 km north to south and tapers from 6 km in width to a single point at its southernmost end which sits directly north of the centre of the development site. The near-vertical edges of the basin contour 13 km of the site boundary in many inlets and steep-sided valleys. This large depression in the landscape is interspersed with largely dry but seasonally inundated wadi systems. There is past evidence of farming activities within the basin where centre-pivot irrigation systems have been situated. These are no longer is use and there is little to no vegetation within the entire basin owing to numerous nomadic groups of livestock grazing year-round.

The Dumat al Jandal development site is located in a region that is notable for the presence of a significant migratory bird flyway. The East Asian/East African Flyway is known to involve a broad corridor of movement, which is generally to the north-east in spring and to the south-west in autumn. This flyway has been described in literature (BirdLife International, 2010) (Section 3.2.1, Figure TB27) but is not well known and is particularly ill-defined in KSA. There is also a more general migratory bird movement through the Arabian Peninsula in spring (northwards) and autumn (southwards) which may result in increased bird activity within the development site during migration periods (Zalles & Bildstein, 2000).

A primary ecological concern of wind energy development is the potential impact upon birds and as such birds are a key focus of the ecological assessment of the Dumat al Jandal Wind Energy Park. The survey and assessment method used in this report is based on UK best practice survey guidance (Scottish Natural Heritage (SNH), 2014) and also takes account the guidelines of the International Finance Corporation (IFC) and BirdLife International (see Section 2).

Wind energy developments pose three main potential risks to birds (SNH, 2014):

- **Collision** of birds with wind turbines and other infrastructure leading to death or injury.
- **Displacement or barrier effects** caused by wind farm development may lead to birds avoiding the area and/or diverting flight paths due to the construction and/or operation of the wind farm.

- **Direct habitat loss** due to the development of wind farms and associated infrastructure may result in the loss of habitats that support breeding, wintering and/or migratory species.

To appropriately assess each of these risks, a detailed understanding of the bird activity within the development site and surrounding airspace is required. A desk-based study and comprehensive program of ornithological surveys were conducted in 2017 to provide an appropriate level of baseline information to inform an assessment of the potential impacts of the development.

A full list of bird species recorded at the site is provided in Appendix A. Scientific names are provided in addition to the relevant conservation status and population trend for each species, where available (IUCN, 2017). Bird species are referred to using common (English) names throughout this document.

This ornithological baseline report presents the scope of the study, survey and data analysis methods, results, and a brief discussion of the results to inform the development of Dumat al Jandal Wind Energy Park and is included as an appendix to the Environmental Social Impact Assessment (ESIA) (Document SA217900-04-G-REP-4003). The Ornithological Impact Assessment is detailed within Chapter 11 Terrestrial Biodiversity of document SA217900-04-G-REP-4003.

2. Policy, Legislation and Guidance

2.1 Policy, Legislation and General Guidance

There are a number of key documents relating to nature conservation and ecology that have been considered in relation to the proposed development including policy, legislation and guidance documents. In some cases, these do not relate directly to projects within KSA but are considered on account of their relevance of the approach, international recognition and acceptance as best practice, and the lack of similar documents within KSA. These are listed below, but the full legal and policy framework applicable to the project can be found in the Dumat al Jandal Environmental and Social Impact Assessment (SA217900-04-G-REP-4003). The Birds Directive (2009) is only directly applicable within European Union Member States, but has been referred to due to the potential for European breeding birds to move through KSA on migration:

- Directive 2009/147/EC of the European Parliament and of the Council (Birds Directive, 2009).
- The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1983). KSA is a Party state.
- International Union of Conservation of Nature Red List of Threatened Species (IUCN, 2017).
- Key conservation issues for migratory bird species on the world's major flyways (Kirby *et al*., 2008).
- Wind farms and Birds: An analysis of the effects of wind farms on birds, and guidance on environmental assessment criteria and site selection issues (Langston & Pullan, 2003).

2.2 Survey Guidance

2.2.1 Scottish Natural Heritage Guidance

Scottish Natural Heritage guidance (SNH, 2014) is widely accepted as the global benchmark for ornithological assessment of wind energy development and this assessment is based on the methods described therein, where appropriate. See Section 4 for a detailed explanation of how these guidelines have informed the field survey and data analysis methods.

2.2.2 International Finance Corporation Guidance

The International Finance Corporation (IFC) developed World Bank Group Environmental Health and Safety Guidelines for Wind Energy (IFC, 2015) states the following must be considered during pre-construction assessment of birds:

- Surveys should target those with a special international or national conservation status, endemic species, and species that are at elevated risk of impact from wind energy facilities. For example, species with a relatively high collision risk include certain soaring, aerial-displaying, and/or migratory birds and flocking birds, as well as birds of prey (Guideline 27).
- Species with a relatively high risk of visual disturbance include open-country species that instinctively avoid tall structures. Some species may be attracted to wind energy facilities as perches or feeding areas, which could further increase potential for collision. Species at risk of collision with associated transmission lines include relatively heavy-bodied birds with limited manoeuvrability (e.g., vultures, bustards, waterfowl, cranes, storks, pelicans, herons, flamingos), as well as flocking bird species (Guideline 27).
- Surveys should take into consideration certain periods during the year when the project site may have a greater or different ecological function or value (e.g., migration, breeding season, or winter seasons). Surveys should usually be conducted for at least one year when at-risk wildlife is identified. Longer surveys may sometimes be necessary in areas with exceptional aggregations of at-risk migratory birds and where existing biodiversity data are limited (Guideline 27).
- Surveys should be designed and implemented to adequately guide the micro-siting of turbines (and turbine selection) to minimize collision risks to birds. This is normally expected to entail gathering relatively precise information on the spatial patterns of site utilization by at-risk wildlife species, as well as consideration of the locations of certain topographic, ecological, or other landscape features that may attract or otherwise

concentrate the activity within the project area and its surrounding landscape. Specific data-gathering methods and study designs should be selected based on site and species-specific considerations, guided by technical experts, and may include vantage point (VP) surveys, point count surveys, ultrasound acoustic methods, remote-sensing data-gathering techniques, and/or other techniques to understand movement patterns, as appropriate (Guideline 28).

- The use and effectiveness of radar and/or other remote-sensing technologies in pre-construction studies should be evaluated on a project-by-project basis and may be appropriate to supplement observer-based surveys; depending on the circumstances. Remote-sensing technologies are particularly useful at offshore wind facilities, as observer-based studies are more difficult and expensive in the offshore environment (Guideline 29).
- Depending on the location of the wind energy facility and on species-specific considerations, Collision Risk Modelling (CRM) may be also appropriate, especially when wind energy facilities are located close to areas of high biodiversity value. The utility of CRM is to be evaluated on a project-by-project basis with qualified experts. (Guideline 31).

2.2.3 BirdLife International Guidance

BirdLife International produced standardised guidance on birds and wind farms within the Rift Valley/Red Sea flyway through its Migratory Soaring Birds (MSB) initiative (BirdLife International, 2012). Although the Dumat al Jandal site is not located directly on this flyway the guidance was also used to inform the assessment process. The MSB project, led by BirdLife International in conjunction with the United Nations Development Programme (UNDP) and Global Environment Facility (GEF) outlines four broad requirements for baseline surveys as follows:

- **Migratory bird surveys** which should take place for a minimum of a year to cover the migration seasons. The baseline survey should include VP surveys undertaken during migration periods to assess the potential risks to migratory soaring birds, particularly at or near migration bottlenecks.
- **Breeding bird surveys** to provide baseline data for assessment of the potential impact of a development on breeding species in the area.
- **Vulnerable and protected species-specific surveys** for species which may be present in the area and require individual assessment, e.g. owls, nightjars, locally breeding raptors, colonial breeding species, etc.
- **Wintering bird surveys** may also be required, which could include non-breeding season surveys of resident species, and of over-wintering migrants.

3. Desktop Study

3.1 Methods

The desktop study was undertaken to determine the level and importance of bird activity in the wider vicinity of the development site and to inform the baseline survey approach. Such studies are recommended in a number of guideline documents (see Section 2). Although there is little site or region specific data related to species abundance or distribution, data concerning designated and well-studied ‘migration bottleneck’ sites on the associated East Asian/East African Flyway were evaluated, along with related literature used to identify key species, peak migration periods and defined routes of migration in the region. Important Bird and Biodiversity Areas (IBAs) as identified by BirdLife International are also a crucial source of information in the Al Jouf Province of KSA (see Section 3.2.4).

The desktop study identified and used the following key sources:

- BirdLife International; Important Bird Areas (BirdLife International, 2016).
- BirdLife International; Migratory Soaring Birds Initiative (BirdLife International, 2012).
- International Bird Research Centre data (IBRC); Eilat, Israel (IBRC, 2016).
- Raptor Watch: A Global Directory of Raptor Migration Sites (Zalles & Bildstein, 2000).
- Satellite Tracking EU: Satellite tracking studies in Europe and Russia (Satellite Tracking EU, 2017).
- Trektellen Website: Worldwide Migration Counts (Trektellen, 2017).
- World Bank Group Environmental Health and Safety Guidelines for Wind Energy (IFC, 2015).

The approach taken at Tafila Wind Farm, Hashemite Kingdom of Jordan (hereafter referred to as Jordan), has also been reviewed to inform the assessment process at Dumat al Jandal Wind Energy Park. This wind farm is one of the only operational examples of commercial wind energy development in the Middle East (see Section 3.2.5).

3.2 Results

3.2.1 Migration Routes

The East Asian/East African Flyway (Figure TB27) is one of three key migration routes for birds connecting the Palearctic and African regions; the other two, the East Atlantic Flyway and Mediterranean/Black Sea Flyway are well-known and well-studied; especially at key bottleneck[1] sites (Zalles & Bildstein, 2000, Kirby *et al*., 2008, Bildstein & Sandor, 2016). Collectively, these three migration routes make up the world’s largest bird migration system (BirdLife International, 2010).

The East Asian/East African Flyway is a broad corridor between central to east Asia and Africa (BirdLife International, 2010). A large number of species use the flyway including shorebirds, soaring birds and passerines. Birds generally fly north or north-east in spring and south or south-west in autumn (Boere & Stroud, 2006, Kirby *et al*., 2008, BirdLife International, 2010). The route passes through a vast area in the Middle East that includes Iran, Iraq, Syria and KSA. There is a lack of available information on specific migration routes and bottleneck sites in the region, especially in northern KSA. Associated literature specifically identifies the lack of available historic data within these countries for migratory species using the flyway (Stroud *et al.,* 2006). There is, however, some data available from species-specific study and a few key examples are discussed here.

One detailed record of a ‘typical’ migration route through central Asia to Africa undertaken by a Russian satellite-tagged steppe eagle on autumn migration in 2016 is shown in Figure 1 below (Satellite Tracking EU, 2017). The individual crossed northern KSA in a south-westerly direction, passing within 20 km of the Dumat al

[1] Migration bottlenecks are geographical locations along a flyway where large congregations of birds regularly occur due to external factors that stop, slow or alter migration activity from progressing on a broad front.

Jandal site on 13 September 2016. The bird continued south-west reaching the Taif Escarpment before flying south to the Strait of Bab-el-Mandab and crossing into Africa at Djibouti. This is a steppe eagle autumn migration route that is well-known (Meyburg, 2003) and it is a typical example of the broad route followed by other migrant species (Meyburg *et al*.,1998, Zalles & Bildstein, 2000). Historically, steppe eagles are known to have migrated in a large loop around the Red Sea, returning north on spring migration through north-east Africa, passing ‘bottlenecks’ at Suez and Eilat (Zalles & Bildstein, 2000, Bildstein & Sandor, 2016, Trektellen, 2017). It is thought that an increasing number of steppe eagles are wintering within the Arabian Peninsula and therefore these routes may be increasingly more variable (Meyburg, 2003).

Figure 1: Individual steppe eagle autumn migration route through northern KSA. (Blue X – Proposed Dumat al Jandal Wind Energy Park)

A study into falcon hunting activity in KSA, specifically trapping larger falcons, such a peregrine and saker for recreational falconry, identified three key areas in the Kingdom where a significant proportion of captures had been confirmed (Shobrak, 2015). Two of the areas lie on the west coast of KSA along the Red Sea, which is a well-known migration route associated with the Red Sea/Rift Valley Flyway (Birdlife International, 2012) and is shared in part by birds on the East Asian/East African Flyway as exemplified above in Figure 1. The third trapping area identified in the study lies in a vast and largely uninhabited area in northern KSA between the Dumat al Jandal site and the northernmost city of Turaif, Northern Borders Province. The area covers a significant proportion of the Harrat al-Harrah IBA for which saker falcon is listed as a qualifying species on passage (see Section 3.2.4). Trapping birds for use in falconry is popular pastime in KSA, an area notable for these activities is another indication of the importance of the region for migratory birds.

Broad northward movements of black kite, all harrier species and both kestrel species are known to occur across the Arabian Peninsula in spring (Zalles & Bildstein, 2000). A satellite tracking study of pallid harrier breeding in central Kazakhstan confirmed routes through northern KSA were used on migration in both spring and autumn periods to reach, and return from, wintering grounds in east Africa (Terraube et al., 2012).

The East Asian/East Africa Flyway is less-studied than its counterparts although it seems likely that there are no major bottleneck sites near Dumat al Jandal (BirdLife International, 2016). The closest major bottleneck sites lie in Jordan and neighbouring countries greater than 400 km west of the development site and are associated with the north to south orientated Red Sea/Rift Valley Flyway (Bildstein & Sandor, 2016, Trektellen, 2017).

Although no major bottleneck sites have been identified in proximity to the development site, the available information suggests the flyway passes through the Al Jouf Province where the Dumat al Jandal development site is situated. There is consistent evidence indicating the movement of birds crossing northern KSA from Eurasia, as far east as the Arabian Gulf, then passing south-west/westwards to the Red Sea coast prior to eventual passage into Africa or alternate wintering grounds further south on the Arabian Peninsula (Zalles & Bildstein, 2000), with the equivalent reverse trend for spring movement depending on the species in question (see Section 3.2.3).

The nearby Dawmat al Jandl Wetland IBA (variation on spelling used by BirdLife International) (see Section 3.2.4) acts as a further attractant to birds passing through the region, which may increase the level of passage through the area surrounding the development site. The vast An Nafud desert also lies southeast of the Al Jouf Province. This expansive, sandy and featureless desert extends to eastern KSA and is likely to act as a barrier to migration due to the lack of available water/food sources and the preferred flight behaviours of large, soaring migratory birds which require certain landscape features that create thermal updrafts, which aid migration (Newton, 2016) (see Section 3.2.2).

Dumat al Jandal, including the associated IBA, is therefore an effective refuge, or small 'bottleneck', at the northern extent of this desert which may increase the occurrence of migrating birds in proximity to the development site. A record of a satellite-tagged white stork provides an example of this species' avoidance of vast desert zones in favour of the refuge of farmlands in Al Jouf Province surrounding Dumat al Jandal (Figure 2 below) (Satellite Tracking EU, 2017). The bird returned to the Dumat al Jandal area after attempting to cross a comparably narrow section of the An Nafud desert. The satellite stopped transmitting soon after which indicates the bird may have died whilst on migration.

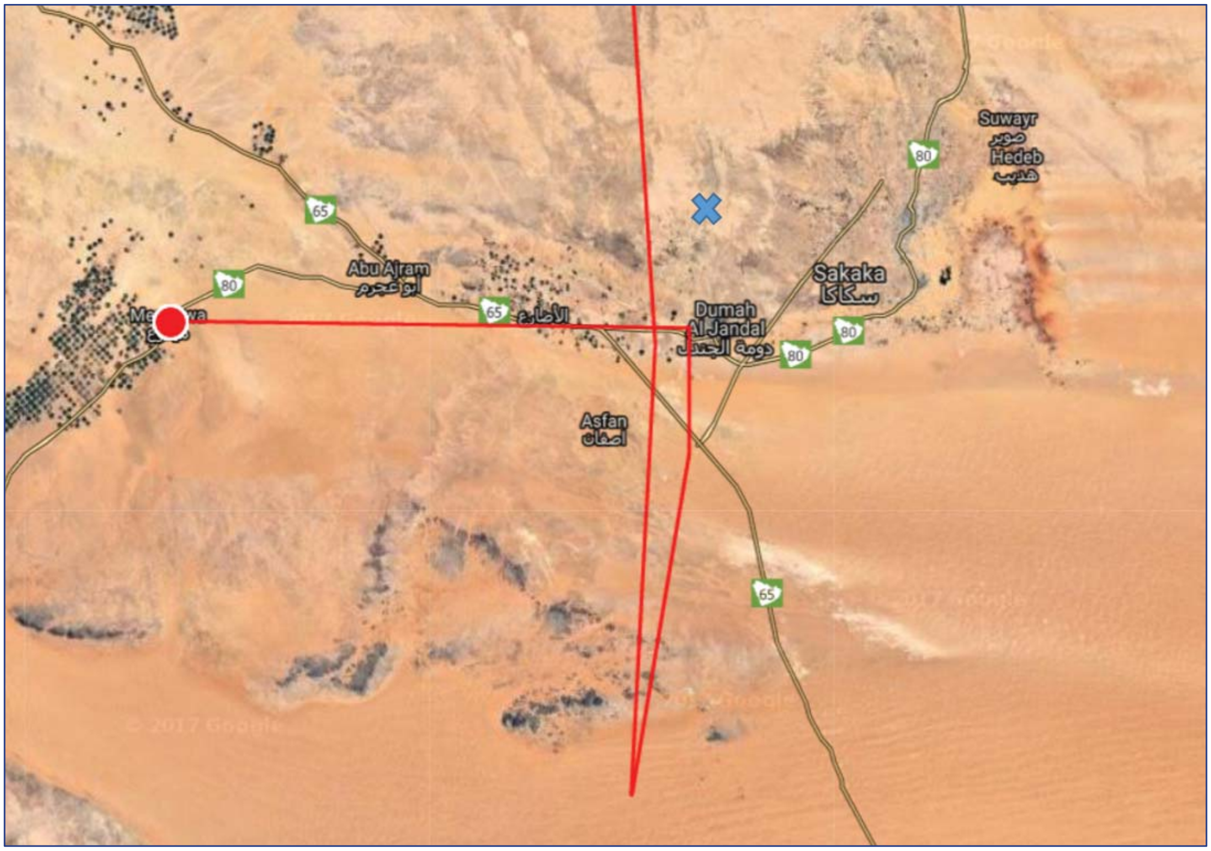


Figure 2: Individual white stork route surrounding Dumat al Jandal. (Blue X – Proposed Dumat al Jandal Wind Energy Park)

3.2.2 Key Species

The key species identified are the soaring and sub-soaring species which are more susceptible to collision with wind turbine blades due to their flight behaviours (Barrios & Rodriguez, 2004, SNH, 2010, BirdLife International, 2012, IFC, 2015, Newton, 2016). This is due to the 'soaring-gliding' flight mode which is used for migration by these species. Where possible, the birds gain height and soar on thermals before gliding (losing height) until the next thermal is reached, this repeated process can result in increased flight activity within the collision risk height zone of wind turbines.

Vultures and eagles are most dependant on soaring-gliding, followed in descending order by *Buteo* buzzards, *Milvus* kites, *Accipter* hawks, and *Pernis* honey buzzards, and then by *Circus* harriers and osprey (Newton, 2016). Falcons are more active fliers, less dependent on updrafts, but make use of them when available (Newton, 2016). Storks and cranes also use this flight mode (BirdLife International, 2012).

Thirty-seven species of raptor regularly occur in KSA and 33 in nearby Iraq. Almost all of these raptors migrate to some extent within their ranges (Zalles & Bildstein, 2000) and a large proportion of these species may occur at the Dumat al Jandal site in northern KSA. The most numerous raptors on the adjacent Red Sea/Rift Valley flyway are black kite, honey buzzard, steppe buzzard and steppe eagle (Zalles & Bildstein, 2000) and, as a consequence, these species are likely to occur within the development site. As discussed in Section 3.2.1, broad movements of many raptor species occur across the north of the Arabian Peninsula (Zalles & Bildstein, 2000). Other key species within the development site may include those found at the nearest IBA, Dawmat al Jandl IBA (see Section 3.2.4).

3.2.3 Migration Periods and Variability of Bird Movement

Raptors, and other migrant species, generally move south from Eurasia into Africa, using the Middle East as a land bridge, from August until early November with northerly spring migration occurring from late February to mid-May (Zalles & Bildstein, 2000, Bildstein & Sandor, 2016).

The migration pattern varies between autumn and spring periods as the birds use different pathways within the main migration corridors. This is particularly notable at the nearest well-studied migration sites (in Jordan) where, across six well-studied sites, up to 32 species of raptor are recorded. Although higher populations migrate in autumn, as juveniles born that year increase the number of birds migrating, this movement tends to be in a broader corridor towards the south of the flyways.

In the Middle East spring passage (northward) is generally more significant at well-studied bottleneck sites than autumn (southward) (Bildstein & Sandor, 2016). This is particularly notable at one of the nearest bottleneck sites on the Red Sea/Rift Valley Flyway, Eilat. Only one raptor species, the steppe eagle, is typically recorded over the site in significant numbers during the autumn compared to over 30 species in the spring (Lesham & Yom-Tov, 1998, Bildstein & Sandor, 2016). The typical passage of approximately 20,000 migrants in autumn and 830,000 in spring clearly shows the temporal variation in the congregations of birds migrating through the site (Bildstein & Sandor, 2016).

As a general rule, however, the reverse trend is evident further north on the flyways whereby significantly larger concentrations occur in autumn. The migration bottleneck at Batumi, Georgia, 1300km north of Dumat al Jandal follows this trend. It is deemed to be the most important autumn flyway bottleneck in Eurasia, with over a million raptors recorded on passage each autumn (Bildstein & Sandor, 2016).

Migration activity varies temporally within each individual season as different species migrate at differing times. There is evidence of this during spring migration at one of the main bottleneck sites in the Middle East, Eilat, as steppe buzzard and steppe eagle move north through the site in significant numbers throughout March. In contrast, honey buzzard is not recorded until late April and early May when the majority of the species (>400,000 birds) pass through in a matter of days (IBRC, 2015, Bildstein & Sandor, 2016).

Weather conditions can have an effect on bird migration. Although the influence of weather on migration is complex and varies depending on species, but in general inclement conditions e.g. rain, mist, heavily overcast conditions and strongly opposing winds can temporarily deter birds, and particularly soaring birds, from migrating. Migration paths can also shift laterally by many kilometres due to cross winds and can be restricted altogether by strong winds in any direction which reduce the prevalence of thermals (Newton, 2016).

Weather conditions can also affect food availability and migration may be delayed or staging sites altered due to the level of food availability pre-migration and along migration corridors (Lopez-Lopez *et al.*, 2014). This can influence the location of stop-overs; with a strategy of short stage migration with many stop-overs used when food availability is low and/or weather conditions poor and longer, more direct, migration with fewer stop-overs when food availability is high and/or weather conditions are good. This variation can also potentially impact upon the detectability of birds along migration corridors.

Surveys at Dumat al Jandal have been tailored to account for the overall expected trends in bird migration and also allow for such variability.

3.2.4 Important Bird and Biodiversity Areas

Important Bird and Biodiversity Areas (IBAs) are key conservation areas which are identified using internationally agreed criteria applied locally by BirdLife Partners and experts (BirdLife International, 2017). The criteria are outlined within a broad range of categories related to population distributions, congregations of certain species and species conservation statuses on two scales, global and Middle Eastern. If a species, or assemblage of species, meets the criteria it is included as a qualifying feature of the IBA. There are over 12,000 recognised sites which make up the largest global network of significant biodiverse sites.

Four sites within 300 km of the Dumat al Jandal development site have been summarised in Table 1 and are illustrated on Figure TB06. The IBAs are arranged by their distance from the development site; all of the IBAs listed are in KSA. Each bird species that is a qualifying feature of the IBA has been listed under four seasonal headings; resident (year-round), breeding-only, non-breeding-only or recorded on passage. The nearest IBA site is 13km from the development site, Dawmat al-Jandl Wetland (variation on spelling used by BirdLife International).

At the time of writing there was no clear designated species data available for the Dawmat al Jandl Wetland IBA. Due to the close proximity of the IBA to the development site it was visited on a number of occasions in order to characterise the bird activity within the IBA, particularly at the large man-made reservoir and associated irrigation ditches (see Section 4.8). The desk-based study revealed historic records of large numbers of over-wintering Eurasian coot and large flocks of white-winged tern (> 1000) in late April may be species records that factor in the designation of the IBA (BirdLife International, 2017) although this could not be confirmed at the time of writing.

Table 1: Summary of IBAs in relation to Dumat al Jandal Wind Energy Park (BirdLife International, 2017)

IBA	Country	Description	Habitat	Size (ha)	Distance from site (km)	Number of Qualifying Species			
						Resident	Breeding	Winter	Passage
Dawmat al-Jandl Wetland	Kingdom of Saudi Arabia	Historically one of the few remaining wetlands in the northern desert surrounded by marshland. Now a man-made reservoir surrounded by agricultural holdings and the town of Dumat al Jandal.	Open raised permanent reservoir basin with irrigation channels running to agricultural areas punctuated by very small, scattered remains of marshland.	2,500	13	-	-	-	-
Harrat al-Harrah	Kingdom of Saudi Arabia	Large desert with basalt boulder fields and volcanic cones.	Siltflats, saltflats, shallow wadis, permanent reservoir and small scrub.	1,377,500	50	9	2	3	2
At-Tubayq	Kingdom of Saudi Arabia	Raised platform of old, dark sandstone 300-400m above a sandy plain.	Ephemeral plant growth after rain, drought resistant shrubs and grass.	1,220,000	150	1	1	-	-
Jabal Aja and Northern Ha'il	Kingdom of Saudi Arabia	Mountainous region adjacent to semi-desert and the Jabal Aja and Northern Ha'il city south of the An Nafud Desert.	Extensive granite mountains with deep *Acacia*-lined valleys and adjacent semi-desert. One of the most vegetated areas in the north; the desert and sandstone hills bloom during wet springs.	400,000	280	4	1	2	6

3.2.5 Tafila Wind Farm

The Tafila Wind Farm in Jordan is the first commercial utility-scale wind project in the region (Masdar, 2016). The 117 megawatt (MW) site became operational in September 2015 and is the only operational example which is comparable to the proposed Dumat al Jandal Wind Energy Park.

The Tafila site lies along the Red Sea/Rift Valley flyway, in proximity to an IBA designated for 39 bird species. Baseline bird surveys were carried out across 34 days between October 2011 and September 2012 (inclusive) (Jordan Wind Project Company (JWPC), 2012) with further surveys conducted during the following spring migration (27 February to 18 May 2013) to inform the impact assessment for the wind farm (JWPC, 2013). These surveys combined sampling approaches, such as line transects and spot counts, with VP surveys. International guidance (BirdLife International, 2012) was followed in relation to general survey and SNH guidance (SNH, 2000) used to inform VP survey methods and Collision Risk Modelling.

4. Survey Methods

4.1 Objectives

The objectives of the bird surveys are as follows:

- To provide data on the activity levels, flight behaviour, and distribution of target species (Section 4.4.2) within, and in the vicinity of, the development site during migration seasons.
- To provide input data for Collision Risk Modelling.
- To provide data on the general assemblage of species present within the development site; including wintering, breeding and migratory species.

In accordance with international guidance (BirdLife International, 2012; IFC, 2015) the use of radar and remote monitoring technologies was considered. Due to country-specific restrictions on such technology and equipment, in association with the requirement to deliver CRM, observer-based surveys were the only option available for data gathering (SNH, 2014).

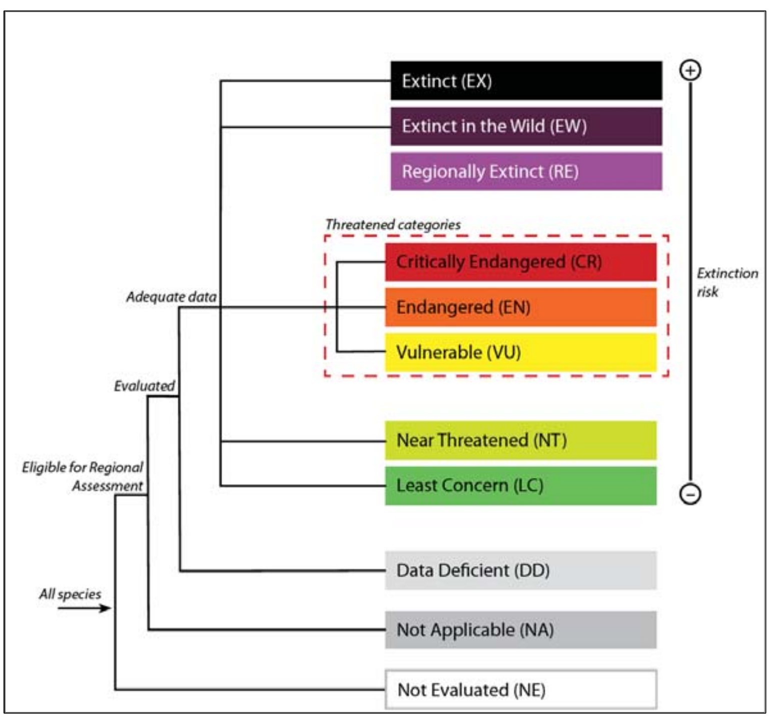
4.2 KSA Bird Codes

Prior to the commencement of survey work, an indicative index of bird species of the region was produced. Unique three-letter codes were attributed to each species for recording purposes during surveys (Appendix B).

4.3 IUCN Classifications

Due to the presence of migratory species that move large distances (crossing a number of country borders), and the lack of locally specific data from KSA, the IUCN red list has been used, where possible, to provide a conservation status for each relevant species (see Chart 1) as well as population trends for all species recorded within the development site. These are included for all species listed in Appendix A.

Chart 1: IUCN Conservation Status Classification System.



4.4 Vantage Point Survey Methods

4.4.1 Survey Effort and Timings

Survey periods were adapted to focus on the autumn and spring migration periods (see Section 3.2.3), given that the habitats present within the development site are unlikely to support breeding or wintering target species. VP effort was increased significantly in these periods compared to the standard six hours per month per VP (SNH, 2014). Observations were spread throughout daylight hours, with a proportion of surveys occurring at dusk and dawn.

Due to the lack of available information on migrant activity across each separate migration season a significant level of survey effort was undertaken in both seasons. Twenty-seven hours of observations were undertaken from each of the nine VPs (Figure TB09, Section 4.4.3) between 12 March and 2 May 2017 during the spring migration season. Twenty-four hours of survey were undertaken from each of the same nine VPs between 6 September and 24 October 2017 during the autumn migration season.

Full details of the survey dates, times, observers and weather conditions to date are provided in Appendix C.

4.4.2 Target and Secondary Species

In the absence of nationally specific guidelines for KSA, survey methods were based on international (BirdLife International, 2012, IFC, 2015) and UK best-practice guidance (SNH, 2014). VP surveys focused upon target species which may, as a result of their flight patterns or response behaviour, be subject to impact from wind farms (Barrios & Rodriguez, 2004, SNH, 2010). The key target species during both spring and autumn migration periods were identified as all raptors and soaring migrant species (see Section 3.2.2). Secondary species, i.e. all other birds, were recorded incidentally during VP surveys.

4.4.3 VP Locations and Visibility

VP locations were selected with the aim of providing maximum visibility, from the minimum number of survey locations, of the provisional turbine layout within the development site. The VP locations and provisional turbine layout are shown in Figure TB09, with nine VPs selected to achieve efficient coverage (see Figure TB09). Sixteen turbine locations were not directly within view arcs of the nine VPs (see Section 4.9.1). Each VP location allows visibility of a 180^{o} degree arc extending up to two kilometres from the observer.

Guidance states that, where possible, observers should not be situated within the site boundary (SNH, 2014). This was not possible due to the low-lying surrounding landscape below the site that would have precluded adequate visibility into the site from outside the site boundary, as well as the overall size of the development site. This measure is aimed at reducing observer impact upon bird behaviour, particularly breeding species, and is less likely to affect birds on migration.

As the site plateau is relatively flat, full visibility of the collision risk zone (CRZ) (i.e. the likely rotor-swept area; see Section 4.4.5), within the provisional turbine envelope, is possible from all nine VPs without exception. Visibility at ground level is also very good and viewshed analysis is not considered to be necessary.

No VPs had overlapping view arcs. During days where significant passage occurred through the site, particularly during the autumn survey period, birds were recorded when outside of the viewing arc of each VP as supplementary information.

4.4.4 Recording Method

Activity patterns, and time spent flying within the area visible from each VP were recorded. The main purpose of VP watches was to:

- Collect data on target species that will enable estimates of:
  - the time spent flying over the development site;

  - the relative use of different parts of the development site; and
  - the proportion of flying time spent within the provisional lower and upper height limits of the CRZ as determined by the rotor diameter and rotor hub height of the wind turbines (see Section 4.4.5).
- Gather an index of presence of other species (secondary species) within the development site.

Methods detailed in SNH, 2014 have been designed to identify and characterise year-round activity, in particular breeding and wintering activity. The method adopted for this study has been adapted to focus on the migration period at the Dumat al Jandal development site (BirdLife International, 2012). However, adapting the survey method did not affect survey watch durations (three hours), recording methods, and associated controls to avoid observer fatigue.

During VP survey the viewing arc was scanned constantly until a target species was detected. The bird, or flock of birds, was then followed until it landed or was lost to view. The following information was recorded for each target species on a standardised form:

- start time of observation;
- duration of observation;
- species, age and sex (where possible);
- count;
- time spent in each height band (see Section 4.4.5); and
- flight route through the development site.

The following meteorological variables were recorded for each hour of survey:

- wind direction;
- wind speed: Beaufort scale from 0 (no wind), to 12 (hurricane);
- temperature (° C);
- visibility: 0 (poor < 1 km), 1 (1-2 km), 2 (> 2 km);
- cloud cover: Okta scale from 0 (no cloud), to 8 (complete cloud cover);
- cloud height: 0 (0 m), 1 (0-500 m), 2 (>500 m); and
- precipitation (type, intensity and duration).

4.4.5 Survey Height Bands

All target species flights recorded during VP surveys were allocated a height band (see Table 3, in Section 4.4.5.1). Survey height bands were determined according to the dimensions of turbines under consideration at the commencement of survey works (March 2017) based upon information provided by Saudi Aramco. These height bands covered the potential CRZ (75 m to 205 m above ground level (agl)) with precaution, especially at the upper CRZ height limit (band C). Height band C is, in effect, the collision risk height band although an additional band B is included to accommodate any future event that reduces turbine height prior to construction of the Dumat al Jandal Wind Energy Park, a scenario which is considered possible. Any future reduction in height is unlikely to reduce the CRZ below 30 m and therefore band A (0-30 m) is maintained. The spring migration VP surveys were undertaken using the height bands shown in Table 2.

Table 2: VP Height Band Summary

Height Band (m agl)			
A	B	C	D

Height Band (m agl)			
< 30	30-70	70-220	220+

4.4.5.1 Turbine Height Amendments

Prior to the commencement of autumn migration VP surveys it was indicated that a new, much larger, model of wind turbine was proposed for the Dumat al Jandal Wind Energy Park development. The exact turbine model was not confirmed at the time of surveying although a model equivalent to General Electric's (GE) 4.8MW-158 largest specification was suggested. The VP surveys were therefore based on the potential CRZ of the largest GE onshore turbine model with a hub height of 161 m and rotor diameter of 158 m. The resulting CRZ of 82 m to 240 m agl was surveyed during the autumn migration VP surveys using the height bands outlined in Table 3. Due to the unprecedented height of the indicated turbine model particular caution was taken when identifying flight heights at the upper CRZ height band limit (band C into band D). The lower height bands A and B remained unchanged between the survey periods.

Table 3: Amended VP Height Band Summary

Height Band (m agl)			
A	B	C	D
<30	30-70	70-275	275+

Upon completion of the surveys it was indicated that a turbine model with a hub height up to 155 m and rotor diameter of 140 m was proposed. As a result, the 'final' potential CRZ for the purposes of this report is 70 m to 240 m based on a precautionary buffer of a turbine model of 85 m to 225 m agl (see Figure 3). This precaution is aimed at addressing the wider area of swept air around the turbine blades and to avoid any underestimation of risk through the estimation of flight heights by observers, particularly at the upper height limit.

As 70 m is used as the lower end of the surveyed CRZ throughout the survey period no change has been considered at the lower end of the rotor swept area. There is, however, a significant difference at the upper CRZ limit between 240 m and 275 m, the impact of this change in relation to the recorded flight data is discussed further in Section 4.4.5.2.

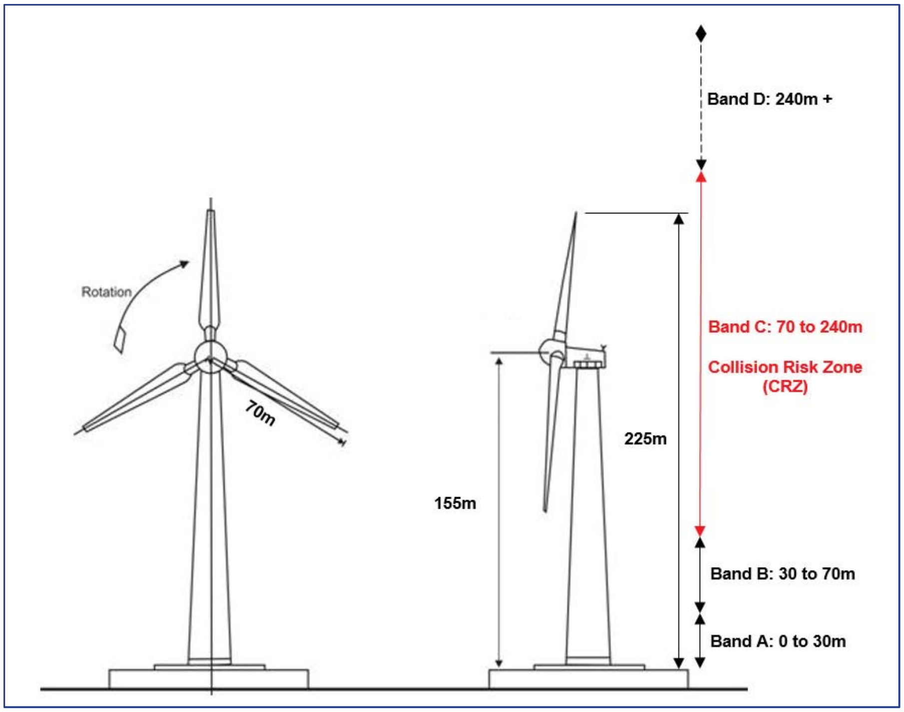


Figure 3: Proposed turbine specification with final height bands considered for the CRM process

4.4.5.2 Flight Lines and Turbine Height Amendments

Due to the change of height band C and band D between the spring and autumn migration periods a review was undertaken of the flights recorded above the CRZ during the spring migration period, prior to the increase in turbine height, i.e. flights within the original band D (215+ m) (Table 2).

Thirteen target species flights were logged within this band during the spring migration period. Twelve of these flight lines were of birds that gained height through CRZ band C before reaching heights over 215 m (band D). Due to the time spent within band C these twelve flights are already included in the Regular CRM process and remain unchanged. A single flight of a steppe eagle recorded on 25 March was logged in band D only. As an average height of 220 m was noted for the flight it has been reassigned to be included in the CRM process within the amended CRZ buffer (70 m to 240 m). This is the only change made to the spring VP data as a result of the turbine height change and subsequent height band amendments.

Eight target species flights were recorded during the autumn survey period in band C (see Table 3) with average heights above the height of the amended CRZ (70 m to 240 m); these average heights ranged from 250 m to 275 m. Due to the variability in height of the target species recorded and the soaring-gliding flight action adopted by these species on migration (Newton, 2016) (see Section 3.2.2), the birds are judged likely to have spent time within the CRZ during the time spent over the turbine area, and these eight flights have been included in the CRM process to avoid any underestimation of risk.

4.4.6 Collision Risk Modelling

All VP data were collected in a format suitable for Collision Risk Modelling (SNH 2000, 2010 & 2016) and CRM has been undertaken for all target species recorded at collision risk height regardless of their location within the development site. This step helps to avoid an underestimation of collision risk.

There are two ‘Band’ models available for CRM (Band *et al.*, 2007). A straightforward model used for regular flight patterns, the Regular Model, and another used for irregular flights such as breeding activity, displaying and random flight behaviours, the Random Model.

The Regular Band model was chosen as the appropriate model for CRM at the development site. This model is used for regular flight paths of birds in reasonably defined directions, such as when on migration, through habitually-used flight corridors (SNH, 2000). The model can be separate into three main stages.

Stage One: Determining how many birds may fly through the rotor swept zone.

- The first-step of the model requires a risk ‘window’ to be identified; this is a cross-section of airspace where ‘at risk’ birds pass through. This is a two dimensional window (W) which covers the maximum area occupied by the turbines within the section of the proposed development site which is the subject of the model. This is calculated by multiplying the width of the area where turbines will be situated by the height of the collision risk zone (turbine rotor radius (R) x 2). This can be undertaken for the entire development site or the site can be split into smaller sections which can potentially increase the accuracy of the model.

$$W = width \times height\ (2 \times R)$$

- The second-step is to estimate the number of birds (n) that may pass through the above cross-sectional area or ‘window’ in a given timeframe. This is determined by using the data gathered during VP surveys. It is calculated as the number of birds observed (B), within collision risk height (2R) (Section 4.4.5.1), flying through the area of the site being modelled, divided by the observation effort (hours of VP survey (O)) which is then multiplied by the available hours (H) for such flights to occur in the given timeframe. The timeframe can vary for each species and within each season and is determined on a case-by-case basis. The available hours inputted into each model, for each species is discussed in Section 4.4.6.1.

$$n = \left(\frac{B}{O}\right) \times H$$

- The third-step is to calculate the total area within the ‘window’ which is swept by the turbine rotors, in the section of the development site which is subject to the model. To achieve this, turbine rotors are hypothetically flattened onto a one dimensional plane. This is the equivalent of pushing multiple rows of turbines into a single row and the sweeping rotors occupy airspace along the same plane but do not overlap. The equivalent rotor area (A) within the risk window (W) is calculated by multiplying the number of rotors (N) by Pi x rotor radius x rotor radius (πR^2).

$$A = N \times \pi R^2$$

- The fourth step is to combine step one and three to indicate how much of the risk ‘window’ (W) is swept by the hypothetically flattened area of turbine rotor blades (A). This calculates the proportion of the rotor swept area (P) within the risk window (W).

$$P = \frac{A}{W}$$

- The last step of this process is to determine the number of birds (n) passing through the rotor swept proportion (P) of the risk window (W). This is calculated by multiplying the number of birds by the proportional area of the rotor blades within the collision risk window.

$$number\ of\ birds\ passing\ through\ rotors = n \times P$$

Stage Two: Calculating the probability of a bird being hit when flying through the rotor blades.

- The second stage of the regular model predicts the percentage of birds that will collide with rotor blades. This is based upon a number of simplifications and is calculated using a standardised spreadsheet produced by SNH (SNH, 2017). A brief summary of how the figure of collision probability is calculated is provided below, full details can be referred to within the guidance (SNH, 2000).
- There are two primary simplifications. The first concerns the shape of the bird, the model calculations can only work on a one dimensional basis and therefore the ‘bird’ is a simple cruciform shape (+), which is determined by the average length and wingspan of the bird species. A literature review was required to

gather this information which is presented for all target species in Section 4.4.6.2, The model can take into account if the bird is flapping or gliding; flapping increases the likelihood of colliding with the rotor blades. The model also assumes that birds fly directly at the cross-sectional 'window' at a 90° angle. This simplification is justified to be offset by birds that do not fly directly at a 90° angle to the turbines and therefore spend more time at risk of collision.

- The second key simplification is a similar two-dimensional flattening of the rotor blade. The rotor blade has an angle (pitch) and a width (chord) which determines the area swept by the rotor blade. The area swept by the blade depends on the distance along the rotor radius (R). Rotors are wide at the hub-base, widen to their greatest width partly along the blade, before tapering to the tip; this is captured by the model. The calculation of blade width along the blade is standardised using a set formula and calculates width at 0.05R intervals along the radius (SNH, 2000).
- The speed of the rotor, in rotations per minute (rpm), is inputted to the model along with the average speed of the bird species in question in metres per second (m/sec). Once again a literature review was required to gather this information, average flight speeds are provided for all target species in Section 4.4.6.2.
- The model thereafter calculates the probability of a bird hitting the rotor at different locations along the blade. As the rotor blade thins towards the tip there is less surface area to collide with although it also moves faster towards the tip extent, this is accounted for within the model. The probability of collision is then calculated for the full extent of the rotor; this assumes the bird flying through the rotors will pass anywhere along the blade at random.
- Probability is calculated for upwind and downwind flights. Collision probability is greater upwind as the bird moves slower through the rotor swept area. The upwind and downwind probabilities are then averaged which results in the average collision probability of the bird being hit when flying through the rotor blades.

Stage Three: Combination of Stage One and Stage Two.

- The results of stage one and stage two are combined by multiplying the number of birds passing through the rotor swept area (n) by the probability of those birds actually colliding with the rotors (Stage 2). This is then 'corrected' for the period of time turbines are likely to be in operation due to, for example, breakdowns or lack of wind (85 %) (BWEA, 2017). This gives the number of predicted collisions assuming no avoidance is taken for the period which the model was run for.
- Avoidance rates can then be applied for each species; these are typically 98 % avoidance for most species (SNH, 2010). Although kestrel and the larger vulture species are often reduced to 95 % avoidance, due to their susceptibility, to avoid an underestimation of risk (SNH, 2010, 2016,). This is simply the percentage of birds that will avoid colliding with turbine blades if flying directly towards operational turbines.
- The results of the model are presented twice; the first as the number of collisions per year assuming no avoidance and secondly with the appropriate avoidance rate applied. A figure for the number of years that will pass before a collision event is also provided to put in context the number of potential collisions.

The model can be further refined depending on the detail of the level of flight activity available. The model has been run for each species, at each VP, in each season to provide the most detailed, and precautionary, assessment possible. This predicts higher numbers of birds colliding with the turbines, as a precautionary approach to bird impacts, and allows for freedom in adapting future turbine layouts and specifications. The breakdown and cumulative results of the model are presented for each species (see Section 5.1.6) and within the target species accounts (see Section 5.5).

There are a number of parameters and assumptions required to model the flight activity at the Dumat al jandal Wind Energy Park. As certain details are unconfirmed at the time of writing a precautionary scenario has been created to avoid any underestimation of risk. Model parameters and associated assumptions are detailed in Section 4.4.6.1.

4.4.6.1 Collision Risk Modelling Parameters and Assumptions

- The model has been based on the largest turbine layout of 132 turbines (DNV GL, 2017).

- Turbines outside all VP view arcs have been included statistically within the nearest view arc, this concerns 16 turbines. Turbines on the border of more than one VP view arc of coverage have been included in both VPs to avoid any underestimation of risk, this concerns three turbines.
- All flights originally recorded at collision risk height band C and those discussed in Section 4.4.5.2 are included within the model. Flights below (band A) and above (band D) were not included unless otherwise stated.
- The model assumes the CRZ of any proposed turbine models remain within 70 m to 240 m *i.e.* the lower and upper height limits of the turbine blades are within the CRZ buffer used in the model (70 m to 240 m) (Section 4.4.5.1).
- Indicative turbine parameters have been taken for Siemens SWT-DD-142 turbine (Siemens, 2017a) as this is the turbine of the proposed scale with the most specification details available for the purposes of the model.
- Siemens SWT-DD-142 hub heights range from 99 m to 165 m. A 155 m hub height has been assumed as it is the proposed hub height at the time modelling was carried out (November 2017).
- Rotor blade length is consistent across all hub height specifications at 69.3 m; 70 m has been used within the model as it is maximum potential rotor length as specified by Saudi Aramco.
- Information relating to the speed of the turbine blades for a turbine model of the proposed size was not readily available at time of modelling. For models where speeds were available, speeds varied between four and 16.5 revolutions per minute (rpm) (Siemens, 2017b, 2017c). The fastest speed, 16.5 rpm, has been assumed as it represents the worst-case scenario. Larger turbines are likely to be slower and this is a precautionary measure.
- The pitch of the turbine blades (angle) is assumed at an average of 6 º as per turbine specifications.
- A 98 % avoidance rate is assumed for all species, except griffon vulture and the two kestrel species (95 %) (Lucas *et al*., 2012, JWPC, 2013, SNH, 2016). These are precautionary avoidance rates as literature suggests avoidance rates may be higher for certain target species (Whitfield & Madders, 2006, Whitfield, 2009).
- Actual operational time of each turbine is assumed at 85 % (British Wind Energy Association, 2007).
- The width used for calculating the risk window area (W) is 4 km for each VP as it represents the widest cross-section of the full view arc.
- Ninety-day migration periods during both autumn and spring migration have been assumed for all target species as a basis for CRM. These are overestimates in the available hours (H) for bird activity to occur and are aimed at reducing any underestimation of collision risk.
- The dates assumed for the maximum 90-day migration period are 15 August to 12 November and 15 February to 15 May (inclusive). The period of ‘available hours’ (H) on each day has been derived from daylight hours, between sunrise and sunset, at the nearest major city Sakaka, KSA.
- The ‘available hours’ (H) for each season were calculated as 1120 and 1066 hours during the spring and autumn migration periods, respectively.
- Upon completion of CRM, a process of refining the model to improve accuracy was undertaken for species predicted to have greater than a single collision per year. This concerns four species and the adapted approach focussed on the available hours for flights to occur, the 90-day autumn period was adapted to align with observations of each species at the development site. Available hours (H) were determined as a week either side of the first and last sighting, or the daylight hours across the autumn survey period (584 hours), whichever resulted in a greater number of hours. CRM for the spring period was not adapted. The refined results are presented separately in Section 5.1.7.

4.4.6.2 Target Species Biometric Data

A literature review was undertaken to retrieve target species parameters for the modelling process. Biometric data was gathered using Collins Bird Guide (2009) and is presented as the average length and wingspan of each species in metres as the model works on those measures. Similarly, typical flight speed is presented as metres per second (mps) (Bruderer & Boldt, 2001; Alerstam *et al.,* 2007).

Table 4: Target Species Biometric Data for Collision Risk Modelling

Species	Length (m)	Wingspan (m)	Flight speed (mps)	Avoidance Rate (%)
Black kite	0.53	1.425	12.55	98
Booted eagle	0.465	1.225	13.3	98
Common kestrel	0.34	0.73	12.75	95
Eastern imperial eagle	0.765	1.9	14.75	98
Egyptian vulture	0.6	1.625	14.35	98
Eurasian hobby	0.32	0.77	14.55	98
Eurasian sparrowhawk	0.35	0.675	11.8	98
European honey buzzard	0.555	1.24	13.35	98
Griffon vulture	1.025	2.475	16.5	95
Hen harrier	0.5	1.075	11.6	98
Lesser kestrel	0.3	0.675	11.45	95
Lesser-spotted eagle	0.6	1.555	14.75	98
Levant sparrowhawk	0.335	0.695	12.35	98
Long-legged buzzard	0.54	1.425	14.8	98
Marsh harrier	0.49	1.275	11.55	98
Montagu's harrier	0.445	1.06	11.7	98
Osprey	0.56	1.595	13.35	98
Pallid harrier	0.45	1.075	13.25	98
Purple heron	0.8	1.29	11	98
Saker falcon	0.51	1.17	12.85	98
Short-toed snake eagle	0.655	1.7	13.6	98
Steppe buzzard	0.44	1.125	14.6	98
Steppe eagle	0.68	1.76	15	98

4.5 Constant Effort Survey

Due to the size and inaccessibility of the development site there was limited capacity to undertake planned transect or census surveys. There were health and safety considerations surrounding access to the development site itself (see Section 4.9.1) and there are logistical issues within the site boundary as travel is limited to well-worn tracks which are sparsely spread across the site. As a result, a ‘constant effort’ method was adopted to characterise the bird assemblages present within the development site.

To address the requirement for winter and breeding surveys in line with international guidance (BirdLife International, 2012, IFC, 2015) ‘constant effort’ surveys were undertaken at all times whilst present within the development site. Two 4 x 4 vehicles with designated drivers were used throughout as it is the safest and most efficient method to cover a very large site. This allows the surveyor (passenger) to record all birds observed. This method was used during the winter survey period, January, spring survey period March to May (inclusive) and autumn survey period September to October. Bird activity and peak counts were noted on a daily-basis and included secondary species recorded during VP surveys.

A constant GPS track has been recorded during the surveys undertaken to date and the track shows the consistent coverage of the site in Figure TB12 achieved whilst travelling between VP surveys and other ecological surveys across 77 days spread throughout 2017. Full details of scheduled survey dates, times, observers and weather conditions are provided in Appendix C which provides an indication of when constant effort surveys have been active.

4.6 Species-specific Surveys

The aforementioned constant effort surveys encompassed various times of day where possible, including near dawn and pre-dusk periods, during winter, spring and autumn to gather species-specific information. Presence on site at these times was focused on both resident and migrant crepuscular and nocturnal species that may be present; such as owls and nightjars, in line with international guidance (BirdLife International, 2012, IFC, 2015). Surveys in the hours of complete darkness were not possible due to safety concerns associated with such activities on the remote development site (see Section 4.9.2).

4.7 Incidental Observations

In addition to the structured surveys, incidental observations of birds were recorded throughout the full survey period. These observations included any bird species or activity of note recorded outside of the aforementioned survey periods (e.g. on remote monitoring trail cameras), or the development site boundary and indirect evidence of target species' presence within the development site and adjacent areas (e.g. anecdotal evidence from locals).

4.8 Dawmat al Jandl Wetland IBA

The BirdLife International designated Dawmat al Jandl IBA (Section 3.2.4) was visited sixteen times during the full survey period. A single visit was undertaken in winter (27 January 2017) with nine between 16 March and 29 April 2017 (inclusive) and six between 9 September and 21 October 2017 (inclusive). Full access to the IBA was not possible during one visit in the autumn survey period due to celebrations for Saudi National Day on 23 September 2017.

Visits to the IBA were undertaken with a view to building a basic and indicative species list for the IBA as this information was not available online. The visits were undertaken for two hours in the morning and counts of species, especially those in abundance, were often estimated to the nearest ten to increase time available to explore other areas of the IBA. All visits were undertaken by the surveyors who were surveying the Dumat al Jandal development site.

4.9 Survey Limitations

4.9.1 Vantage Point Coverage

Sixteen proposed turbine locations were not within the view arcs of the nine VP locations (see Figure TB09). Due to the homogenous landscape across the development site combined with unrestricted views from each VP location it is considered unlikely that even a small level of additional migration through these areas of the development site could go undetected.

4.9.2 Access Issues

There are three suitable access points to the site, a road bridge over the railway line in the west and two other locations where tracks have been scored into the steep plateau edge (see Figure TB07). All three access points require significant off-road driving to reach. It is also difficult to relocate these access points once on-site, with the exception of the railway bridge; a GPS unit is required during daylight hours as there are no distinctive features on the desert plateau to retrace the access points. Due to these reasons, combined with patchy mobile and satellite phone coverage on the development site, the site cannot be safely accessed during the hours of darkness.

4.9.3 Weather Conditions

Dust and sandstorms reduced visibility to less than one kilometre on three separate dates for partial periods of VP survey during the spring survey season (12, 13 and 30 April 2017). Dust, heat haze and fog also created visibility issues between one and two kilometres on nine further dates during the full VP survey period. These visibility issues were temporary lasting less than an hour on all occasions.

Professional judgement was relied upon to determine the acceptability of conditions during each survey and no surveys were abandoned due to adverse weather conditions. Full details of survey dates, times, observers and weather conditions are provided in Appendix C.

4.9.4 Data Discrepancies

Upon completion of the spring VP surveys some discrepancies were identified within the flight line data which are now understood to be underestimations of flight durations for certain flight lines. A total of 27 flights are thought to be underestimated. As the Regular Collision Risk Model was used and doesn’t require flight time data no further action was taken (see Section 4.4.6) (SNH, 2000, 2010, 2016).

In future, if the alternative model (the Random model) is required to be used, which does require flight second inputs; these flights will be multiplied by an appropriate factor to avoid any underestimation of collision risk. This correction will be based on known average flight speeds of the species involved.

5. Results

A total of 84 species have been recorded on site during the planned surveys and through incidental observations to date. Twenty-six are considered to be target species, with common crane, golden eagle and peregrine falcon recorded separately in addition to the 23 target species observed during VP surveys (see Section 5.1).

No endemic species were recorded although the first record of little bustard for KSA (see Section 5.6.1) and a first confirmed record of residency for KSA, the see-see partridge, are notable (see Section 5.6.2).

A full list of species observed on-site has been produced and is provided in Appendix A. Full target species accounts are provided in Section 5.5 with secondary species accounts in Section 5.6.

5.1 Vantage Point Survey

5.1.1 Overview of Target Species Flights

Across the full VP survey period, 6160 individual birds of 23 target species were recorded with 759 flight lines recorded. Due to the level of flight activity at peak times, particularly during the autumn migration period, large groups of birds were recorded on 'combined' flight lines. On occasion these combined flight lines (i.e. a flight line for more than one individual bird), also contained more than one species. Up to six target species were recorded simultaneously within migrating groups during the autumn season.

Over 100 individuals were recorded for five species. These included:

- steppe buzzard - 5271 individuals and 209 flight lines;
- European honey buzzard - 187 individuals and 33 flight lines;
- black kites - 132 individuals and 59 flight lines;
- marsh harrier - 127 individuals and 92 flight lines; and
- pallid harrier - 113 individuals and 109 flight lines.

An overview, combining the data from both migration seasons, is presented in Table 5. The table does not contain height band data as the time spent in each height band is not directly comparable across the full survey period due to the amendment of height bands between the two separate seasons, as discussed in Section 4.4.5.1.

Information in relation to bird flight durations (in seconds) provided represents the total observed flight duration of all birds (i.e. where flights involved more than one bird, flight time was multiplied by the number of individuals involved). Flight duration represents the length of time birds were observed in flight irrespective of flight line location and does not necessarily reflect the time spent flying within areas where birds may be susceptible to collision with turbines.

Flight lines for the target species recorded during the spring migration period are shown in Figures TB18:1 to TB18:15 and autumn migration in Figures TB19:1 to TB19:15. All flight lines shown within the figures are assigned a unique flying bout reference, related to the KSA species code (see Section 4.2, Appendix B), which can be cross-referenced with the raw flight line data included in Appendix C. Bout references are restarted numerically for each season to maintain clarity. Flight activity 'heat maps', showing the relative density of all target species flights, are also provided for each survey period, spring and autumn, in Figures TB18:16 and TB19:16, respectively.

Table 5: Summary of all target species flight lines

Species	Flights	Flight Time (Seconds)	Total number of individuals	Flights at collision height	Total number of individuals at collision height	Max. number of birds observed concurrently
Black kite	59	33327	132	31	72	7
Booted eagle	14	4209	17	10	11	3
Common kestrel	66	7830	73	4	4	3
Eastern imperial eagle	2	404	2	1	1	1
Egyptian vulture	6	2606	6	5	5	1
Eurasian hobby	2	115	2	0	0	1
Eurasian sparrowhawk	10	2350	14	4	4	2
European honey buzzard	32	98736	187	29	181	45
Griffon vulture	1	5184	8	1	8	8
Hen harrier	5	794	6	2	2	2
Lesser kestrel	20	3829	29	3	4	4
Lesser-spotted eagle	3	434	3	3	3	1
Levant sparrowhawk	1	286	1	1	1	1
Long-legged buzzard	23	12352	37	16	29	5
Marsh harrier	92	26343	127	27	46	7
Montagu's harrier	40	5691	44	4	5	2
Osprey	1	342	1	1	1	1
Pallid harrier	109	11254	113	9	9	2
Purple heron	1	7733	19	1	19	19
Saker falcon	1	220	1	1	1	1
Short-toed snake eagle	10	1918	6	7	7	1
Steppe buzzard	209	2128225	5271	139	3796	355
Steppe eagle	52	15203	61	43	51	2
Total	**759**	**2369385**	**6160**	**342**	**4260**	**-**

5.1.2 Spring Migration Target Species Flights

Across the spring VP survey period 181 individual birds of 14 target species were recorded. The spring VP surveys generated a total of 131 flight lines.

Over ten flights were recorded for five species. These included:

- marsh harrier - 42 individuals and 32 flight lines;
- steppe buzzard - 36 individuals and 17 flight lines;

- Montagu's harrier – 20 individuals and 16 flight lines;
- pallid harrier – 18 individuals and 18 flight lines; and
- common kestrel – 14 individuals and 13 flight lines.

Ten or fewer flight lines were recorded for all other target species. An overview of the VP data from the spring migration period is presented in Table 6. The proportion of time spent flying within each height band is given to the nearest integer. It is worth noting that the proportion of flight seconds in each height band within the table correspond to the original height bands as detailed in Table 3Table 2, Section 4.4.5.1, as the flights were recorded prior to the turbine height amendments.

Flight lines for the target species recorded during the spring migration period are shown in Figures TB18:1 to TB18:15. All flight lines shown within the figures are assigned a unique flying bout reference, related to the KSA species code (see Section 4.2, Appendix B), which can be cross-referenced with the raw flight line data included in Appendix BD. A flight activity heat map, showing the relative density of all target species flights in the spring period is also provided in Figure TB18:16.

Table 6: Summary of all target species flight lines during the spring survey period

Species	Flights	Flight Time (Seconds)	Total number of individual birds	Max. number of birds observed concurrently	Band A %	Band B %	Band C %	Band D %
Black kite	6	1073	13	5	37	34	29	0
Common kestrel	13	1773	14	2	78	22	0	0
Eurasian sparrowhawk	1	60	1	1	0	0	100	0
European honey buzzard	1	882	3	3	0	0	53	47
Griffon vulture	1	5184	8	8	0	0	73	27
Hen harrier	3	508	4	2	77	12	11	0
Lesser kestrel	1	180	2	2	100	0	0	0
Long-legged buzzard	3	225	3	1	0	53	47	0
Marsh harrier	32	6221	42	5	43	40	16	<1
Montagu's harrier	16	1743	20	2	67	18	9	7
Pallid harrier	18	1092	18	1	81	5	8	5
Short-toed snake eagle	9	1867	5	1	2	52	46	0
Steppe buzzard	17	5304	36	9	0	9	33	58
Steppe eagle	10	1823	12	2	8	21	57	13
Total	**131**	**27935**	**181**	-	-	-	-	-

5.1.3 Autumn Migration Target Species Flights

Autumn migration surveys generated a total of 628 flight lines of 22 target species.

Over 50 individuals were recorded for six species. These included:

- steppe buzzard - 5235 individuals and 192 flight lines;
- European honey buzzard - 184 individuals recorded and 31 flight lines;
- black kite – 119 individuals and 53 flight lines;
- pallid harrier - 95 individuals and 91 flight lines;
- marsh harrier - 85 individuals and 60 flight lines; and
- common kestrel – 59 individuals and 53 flight lines.

Forty-nine steppe eagles (42 flight lines) is also worth noting. An overview of the VP data from the autumn migration period is presented in Table 7. The proportion of time spent flying within each height band is given to the nearest integer. The proportion of flight seconds in each height band within the table correspond to the amended height bands as detailed in Table 3, Section 4.4.5.1.

Flight lines for the target species recorded during the autumn migration period are shown in Figures TB19:1 to TB19:15. All flight lines shown within the figures are assigned a unique flying bout reference, related to the KSA species code (see Section 4.2, Appendix B), which can be cross-referenced with the raw flight line data included in Appendix BD. A flight activity heat map, showing the relative density of all target species flights in the autumn period is also provided in Figure TB19:16.

Table 7: Summary of all target species flight lines during the autumn survey period

Species	Flights	Flight Time (Seconds)	Total number of individual birds	Max. number of birds observed concurrently	Band A %	Band B %	Band C %	Band D %
Black kite	53	32254	119	7	21	13	51	15
Booted eagle	14	4209	17	3	1	10	67	22
Common kestrel	53	6057	59	3	39	50	11	0
Eastern imperial eagle	2	404	2	1	0	24	76	0
Egyptian vulture	6	2606	6	1	0	20	60	20
Eurasian hobby	2	115	2	1	43	57	0	0
Eurasian sparrowhawk	9	2290	13	2	21	53	26	0
European honey buzzard	31	97854	184	45	11	19	70	0
Hen harrier	2	286	2	1	52	0	48	0
Lesser kestrel	19	3649	27	4	37	44	19	0
Lesser-spotted eagle	3	434	3	1	0	0	100	0

Species	Flights	Flight Time (Seconds)	Total number of individual birds	Max. number of birds observed concurrently	Band A %	Band B %	Band C %	Band D %
Levant sparrowhawk	1	286	1	1	0	69	31	0
Long-legged buzzard	20	12127	34	5	5	10	64	21
Marsh harrier	60	20122	85	7	12	30	58	0
Montagu's harrier	24	3948	24	1	56	38	6	0
Osprey	1	342	1	1	0	0	100	0
Pallid harrier	91	10162	95	2	66	16	16	2
Purple heron	1	7733	19	19	0	0	100	0
Saker falcon	1	220	1	1	0	0	100	0
Short-toed snake eagle	1	51	1	1	0	0	100	0
Steppe buzzard	192	2122921	5235	355	4	13	64	19
Steppe eagle	42	13380	49	2	3	7	83	7
Total	**628**	**2341450**	**5979**	**-**	**-**	**-**	**-**	**-**

5.1.4 Spatial Distribution of Target Species Flights

The spatial distribution of flight activity across the full survey period is summarised in Table 8. The spatial distribution data is presented as the total number of flight lines across each of the nine VPs for each species. Species diversity, i.e. the number of different species recorded from each VP, is also provided.

Target species flights period are detailed in Section 5.1.4.1 for spring migration, and in Section 5.1.4.2 for autumn migration. An additional breakdown of the spatial distribution of target species individuals or groups/flocks is provided for the autumn migration period due to the significant number of 'combined' flights. Due to the level of flight activity 94 % of flight lines in the autumn period involved more than one individual bird.

The spatial distribution of flight activity during the full survey period indicates that the highest number of flight lines were recorded at VP1, VP4 and VP5 (109, 134 and 109 flight lines respectively) and the least at VP2 (41 flight lines). The flight activity for the most frequently recorded species, steppe buzzard, was most prevalent at VP5 and VP6. The highest diversity of species was recorded from VP5 (17 species), with the lowest diversity recorded from VP2 (10 species).

Table 8: Spatial Distribution of target species fight lines during the full survey period

Species	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	Total
Black kite	4	2	8	8	11	10	9	3	4	**59**
Booted eagle	2	1	5	0	2	0	4	0	0	**14**
Common kestrel	11	12	10	7	6	3	6	5	6	**66**
Eastern imperial eagle	0	0	1	0	1	0	0	0	0	**2**
Egyptian vulture	1	0	1	1	1	0	0	0	2	**6**
Eurasian hobby	0	0	0	0	1	0	1	0	0	**2**

Species	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	Total
Eurasian sparrowhawk	0	1	2	1	3	1	1	0	1	10
European honey buzzard	10	0	3	0	8	7	0	2	2	32
Griffon Vulture	0	0	0	0	0	0	0	0	1	1
Hen harrier	1	1	0	0	1	0	0	1	1	5
Lesser kestrel	2	0	1	4	2	2	8	1	0	20
Lesser-spotted eagle	2	0	0	0	1	0	0	0	0	3
Levant sparrowhawk	0	0	0	0	0	0	1	0	0	1
Long-legged buzzard	3	0	3	2	5	5	2	2	1	23
Marsh harrier	9	8	16	23	11	6	5	8	6	92
Montagu's harrier	5	1	4	6	14	4	4	0	2	40
Osprey	0	0	1	0	0	0	0	0	0	1
Pallid harrier	27	5	8	12	15	20	10	6	6	109
Purple heron	1	0	0	0	0	0	0	0	0	1
Saker falcon	0	0	0	0	0	0	1	0	0	1
Short-toed snake eagle	1	0	0	1	0	3	0	4	1	10
Steppe buzzard	22	7	29	22	38	41	24	15	11	209
Steppe eagle	8	3	6	6	14	6	4	3	2	52
Total	**109**	**41**	**98**	**93**	**134**	**108**	**80**	**50**	**46**	**759**
Species Diversity	**16**	**10**	**15**	**12**	**17**	**12**	**14**	**11**	**14**	**23**

5.1.4.1 Spatial Distribution of Spring Migration Target Species Flights

Spatial distribution is summarised for the spring migration period in Table 9. The spatial distribution of flight activity during spring migration indicates that higher number of flights were recorded from VP4, VP5 and VP6 (27, 22 and 26 flights respectively) with the lowest number of flights at VP7 (four flights). Flight activity for the most frequently recorded species, marsh harrier, was most prevalent at VP4 where half of the species flights occurred (16 flights). The highest diversity of species was recorded from VP5, VP6 and VP8 (all eight species), with the lowest diversity recorded from VP7 (three species).

Table 9: Spatial distribution of all target species flight lines during the spring survey period

Species	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	Total
Black kite	0	1	0	0	0	4	0	0	1	6
Common kestrel	0	5	1	1	1	0	1	2	2	13
Eurasian sparrowhawk	0	0	1	0	0	0	0	0	0	1
European honey buzzard	1	0	0	0	0	0	0	0	0	1
Griffon vulture	0	0	0	0	0	0	0	0	1	1
Hen harrier	0	0	0	0	1	0	0	1	1	3
Lesser kestrel	0	0	0	0	1	0	0	0	0	1
Long-legged buzzard	0	0	0	0	0	2	0	1	0	3

Species	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	Total
Marsh harrier	1	3	0	16	4	2	1	5	0	**32**
Montagu's harrier	1	0	1	2	9	1	2	0	0	**16**
Pallid harrier	1	2	3	2	2	6	0	2	0	**18**
Short-toed snake eagle	1	0	0	1	0	3	0	4	0	**9**
Steppe buzzard	1	1	3	2	1	7	0	1	1	**17**
Steppe eagle	0	0	2	3	3	1	0	1	0	**10**
Total	**6**	**12**	**11**	**27**	**22**	**26**	**4**	**17**	**6**	**131**
Species Diversity	**6**	**5**	**6**	**7**	**8**	**8**	**3**	**8**	**5**	**14**

5.1.4.2 Spatial Distribution of Autumn Migration Target Species Flights

Spatial distribution is summarised for the autumn migration period in Table 10. The spatial distribution of flight activity during autumn migration indicates that higher numbers of flights were recorded from VP1, VP3 and VP5 (103, 87 and 112 flights respectively) with lower numbers of flights at VP2 and VP8 (29 and 33 flights respectively). The flight activity for the most frequently recorded species, steppe buzzard was most frequently recorded at VP5 and VP6 (37 and 34 flights respectively) where over a third of steppe buzzard flights occurred (71 flights). The highest diversity of species was recorded from VP5 (16 species), with the lowest diversity recorded from VP8 (nine species).

Table 10: Spatial Distribution of all target species flight lines during the autumn survey period

Species	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	Total
Black kite	4	1	8	8	11	6	9	3	3	**53**
Booted eagle	2	1	5	0	2	0	4	0	0	**14**
Common kestrel	11	7	9	6	5	3	5	3	4	**53**
Eastern imperial eagle	0	0	1	0	1	0	0	0	0	**2**
Egyptian vulture	1	0	1	1	1	0	0	0	2	**6**
Eurasian hobby	0	0	0	0	1	0	1	0	0	**2**
Eurasian sparrowhawk	0	1	1	1	3	1	1	0	1	**9**
European honey buzzard	9	0	3	0	8	7	0	2	2	**31**
Hen harrier	1	1	0	0	0	0	0	0	0	**2**
Lesser kestrel	2	0	1	4	1	2	8	1	0	**19**
Lesser-spotted eagle	2	0	0	0	1	0	0	0	0	**3**
Levant sparrowhawk	0	0	0	0	0	0	1	0	0	**1**
Long-legged buzzard	3	0	3	2	5	3	2	1	1	**20**
Marsh harrier	8	5	16	7	7	4	4	3	6	**60**
Montagu's harrier	4	1	3	4	5	3	2	0	2	**24**
Osprey	0	0	1	0	0	0	0	0	0	**1**
Pallid harrier	26	3	5	10	13	14	10	4	6	**91**

Species	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	Total
Purple heron	1	0	0	0	0	0	0	0	0	**1**
Saker falcon	0	0	0	0	0	0	1	0	0	**1**
Short-toed snake eagle	0	0	0	0	0	0	0	0	1	**1**
Steppe buzzard	21	6	26	20	37	34	24	14	10	**192**
Steppe eagle	8	3	4	3	11	5	4	2	2	**42**
Total	**103**	**29**	**87**	**66**	**112**	**82**	**76**	**33**	**40**	**628**
Species Diversity	**15**	**10**	**15**	**11**	**16**	**11**	**14**	**9**	**12**	**22**

Due to the number of birds recorded during the autumn migration period (5979 target species individuals) a significant number of combined flight lines were logged. To provide more detail on the spatial distribution of flight activity the data is also been presented for target species individuals in Table 11. The highest number of individuals were recorded from VP1, VP5 and VP6 (1289, 1265 and 1305 individuals respectively). Discounting the most abundant species, steppe buzzard, the highest number of individuals were recorded at the same three VPs (208, 106 and 176 individuals respectively, of 816 birds). The fewest individuals (51 individuals) were recorded from VP2.

Table 11: Spatial Distribution of all target species individuals during the autumn survey period

Species	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	Total
Black kite	6	2	17	12	21	16	34	8	3	**119**
Booted eagle	2	1	5	0	2	0	7	0	0	**17**
Common kestrel	12	7	11	6	5	3	7	3	5	**59**
Eastern imperial eagle	0	0	1	0	1	0	0	0	0	**2**
Egyptian vulture	1	0	1	1	1	0	0	0	2	**6**
Eurasian hobby	0	0	0	0	1	0	1	0	0	**2**
Eurasian sparrowhawk	0	1	1	1	6	2	1	0	1	**13**
European honey buzzard	103	0	8	0	17	46	0	7	3	**184**
Hen harrier	1	1	0	0	0	0	0	0	0	**2**
Lesser kestrel	2	0	1	4	2	3	14	1	0	**27**
Lesser-spotted eagle	2	0	0	0	1	0	0	0	0	**3**
Levant sparrowhawk	0	0	0	0	0	0	1	0	0	**1**
Long-legged buzzard	3	0	6	3	11	6	3	1	1	**34**
Marsh harrier	16	5	25	7	8	5	4	9	6	**85**
Montagu's harrier	4	1	3	4	5	3	2	0	2	**24**
Osprey	0	0	1	0	0	0	0	0	0	**1**
Pallid harrier	28	3	5	10	14	15	10	4	6	**95**
Purple heron	19	0	0	0	0	0	0	0	0	**19**
Saker falcon	0	0	0	0	0	0	1	0	0	**1**
Short-toed snake eagle	0	0	0	0	0	0	0	0	1	**1**

Species	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	Total
Steppe buzzard	1081	26	339	84	1159	1201	801	413	131	**5235**
Steppe eagle	9	4	7	3	11	5	5	3	2	**49**
Total	**1289**	**51**	**431**	**135**	**1265**	**1305**	**891**	**449**	**163**	**5979**

5.1.5 Temporal Distribution of Target Species Flights

5.1.5.1 Temporal Distribution of Spring Migration Target Species Flights

The temporal distribution of flights within the spring survey period is presented as the first and last day each species was recorded within the development site, in blue (see Chart 2). The number of individuals of each species recorded each day between those dates is also indicated. All dates in the survey period are included in the chart although not all days were surveyed. Dates not surveyed are indicated in grey shading and full survey details are available in Appendix C.

The peak count of target species within the spring VP surveys was on 25 March 2017 when 22 marsh harriers and six steppe eagles were recorded on the same day from VP3 and VP4. The following day, 26 March 2017, a peak count of 18 steppe buzzards was recorded at VP6.

5.1.5.2 Temporal Distribution of Autumn Migration Target Species Flights

The temporal distribution of flights within the autumn survey period is presented as the first and last day each species was recorded within the development site, in orange (see Chart 3). The number of individuals of each species recorded each day between those dates is also indicated. All dates in the survey period are included in the chart although not all dates were surveyed. Dates not surveyed are indicated in grey shading and full survey details are available Appendix C.

Five species have been omitted from the table as single flight lines were recorded for each, these are; Levant sparrowhawk, osprey, purple heron (one flock of 19 individuals), saker falcon and short-toed snake eagle.

The peak count of target species within the autumn VP surveys was on 21 September 2017 when 1022 steppe buzzards and 54 individuals of nine other target species were recorded from VP5 and VP6. The second highest level of activity occurred on 1 October 2017 when 850 individuals of 12 target species were recorded from VP1 in a single survey.

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Chart 2: Temporal Distribution of target species flight lines during the spring survey period.

Species / Dates	12-Mar	13-Mar	14-Mar	15-Mar	16-Mar	17-Mar	18-Mar	19-Mar	20-Mar	21-Mar	22-Mar	23-Mar	24-Mar	25-Mar	26-Mar	27-Mar	28-Mar	29-Mar	30-Mar	31-Mar	01-Apr	02-Apr	03-Apr	04-Apr	05-Apr	06-Apr
Black kite								1											6							
Common kestrel		1						2	1		2	1		2		1									1	
Eurasian sparrowhawk																										
European honey buzzard																										
Griffon vulture																										
Hen harrier																									1	
Long-legged buzzard											1								2							
Lesser kestrel																										
Marsh harrier				1				1	1	2	3	4		22		2							1		3	
Montagu's harrier																										
Pallid harrier					1			1		2				3		1	1		4			1			1	1
Short-toed snake eagle												1							2							
Steppe buzzard			1		1			2	1					1	18			1	5						3	
Steppe eagle	1								1			1		6												
Species / Dates Continued	**07-Apr**	**08-Apr**	**09-Apr**	**10-Apr**	**11-Apr**	**12-Apr**	**13-Apr**	**14-Apr**	**15-Apr**	**16-Apr**	**17-Apr**	**18-Apr**	**19-Apr**	**20-Apr**	**21-Apr**	**22-Apr**	**23-Apr**	**24-Apr**	**25-Apr**	**26-Apr**	**27-Apr**	**28-Apr**	**29-Apr**	**30-Apr**	**01-May**	**02-May**
Black kite			1								5															
Common kestrel							2						1													
Eurasian sparrowhawk						1																				
European honey buzzard														3												
Griffon vulture																					8					
Hen harrier												2						1								
Long-legged buzzard																										
Lesser kestrel					2																					
Marsh harrier					1									1												
Montagu's harrier					3	2	2			1	1	8					1				2					
Pallid harrier					1							1														
Short-toed snake eagle											1		1	1												
Steppe buzzard					1									2												
Steppe eagle											1	1	1													

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Chart 3: Temporal Distribution of Target Species Individuals During the Autumn Migration Period.

Species / Dates	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep	18-Sep	19-Sep	20-Sep	21-Sep	22-Sep	23-Sep	24-Sep	25-Sep	26-Sep	27-Sep	28-Sep	29-Sep	30-Sep
Black kite										12			3	2	1	8	17			14	8	18	2	3		
Booted eagle							1									1	1					5	1			
Common kestrel																1					2	4	5	3		
Eastern imperial eagle																										
Egyptian vulture															1									1		
Eurasian hobby																						1				
Eurasian sparrowhawk														1			2					1	1	6		
European honey buzzard													41	3	26		15									
Hen harrier									1																	
Lesser kestrel										1											1	14	1	4		
Lesser-spotted eagle																										
Long-legged buzzard										2			3		1	4	10					2	1	1		
Marsh harrier									3	1			3	2	1	6	2			2	2	5	15	3		
Montagu's harrier		2				4	2		1	4			3	2	1	3	1					1				
Pallid harrier																	1			1	2	4	2	6		
Steppe buzzard						12	2			33			614	97	342	223	1022			100	2	680	34	133		
Steppe eagle		2	1							1				1		2	5				1	3	2	3		

Species / Dates Continued	01-Oct	02-Oct	03-Oct	04-Oct	05-Oct	06-Oct	07-Oct	08-Oct	09-Oct	10-Oct	11-Oct	12-Oct	13-Oct	14-Oct	15-Oct	16-Oct	17-Oct	18-Oct	19-Oct	20-Oct	21-Oct	22-Oct	23-Oct	24-Oct	25-Oct	26-Oct
Black kite	3		9		1			7		4	1					3		3								
Booted eagle	1							2		2	1					1			1							
Common kestrel	2	1	3	3	2			1	2		5					1	2	9	8			3		2		
Eastern imperial eagle																1			1							
Egyptian vulture		1		2															1							
Eurasian hobby																1										
Eurasian sparrowhawk								1			1															
European honey buzzard	77	2	5	7				2			6															
Hen harrier									1																	
Lesser kestrel	1	1						1	1							2										
Lesser-spotted eagle	1	1			1																					
Long-legged buzzard	1		2	1				2	1	2	1															
Marsh harrier	11	6	1	7	1			2		2	3					3		1	1				1	1		
Montagu's harrier																										
Pallid harrier	4	5	1	2	2			1	16	12	6					6	7	10	2			5				
Steppe buzzard	722	28	326	405	18			96	14	260	46					1	12		13							
Steppe eagle	8		1	2	1			1		3	2					4		1	3			2				

5.1.6 Collision Risk Modelling

Collision risk modelling was undertaken for 22 target species which were recorded at collision risk height band C at any point during the full survey period. Eurasian hobby is the only target species recorded during VP surveys that was not recorded at collision risk height at any point. The breakdown and cumulative results of the modelling, corrected to two decimal places, are presented in Table 13.

The results indicate steppe buzzard is at the highest risk of collision with 63.08 collisions predicted per year, followed by European honey buzzard with 3.67 collisions predicted per year; black kite (1.48 collisions per year); and steppe eagle (1.06 collisions per year). These are the only species for which at least one collision is predicted each year. For the remaining 18 species fewer than one collision each year was predicted although 0.95 collisions were predicted per year for marsh harrier, which is an individual every 1.06 years.

Two further species were predicted to have over 0.5 collisions per year; purple heron (0.58 collisions per year) and long-legged buzzard (0.53 collisions per year). The remaining 15 target species were predicted to have fewer than 0.5 collisions per year. Individual species results are discussed within target species accounts (Section 5.5) using the figures calculated with appropriate species avoidance rates (95-98 %).

5.1.7 Refined Collision Risk Modelling

For the four species for which a collision or more is predicted each year - black kite, European honey buzzard, steppe buzzard and steppe eagle - the model was refined. The ‘available hours’ for flights to occur were refined from the worst-case scenario of the full 90-day autumn migration period. The available hours were reduced in relation to the temporal distribution of flights i.e. the first and last sightings of each species (see Section 5.1.5.2). The refined hours for each species are outlined in Table 12. Hours for the refined modelling of black kite and European honey buzzard have been defined as the available daylight hours during the autumn survey period (6 September to 24 October 2017 (inclusive)) as discussed in Section 4.4.6.1. CRM modelling for the spring survey period remained unchanged.

Table 12: Refined available hours for Collision Risk Modelling

Species	First Sighting	Last Sighting	Refined Available Hours (H)
Black kite	14 September	18 October	584
European honey buzzard	17 September	11 October	584
Steppe buzzard	10 September	19 October	655
Steppe eagle	6 September	22 October	715

The results of the refined model are presented in Table 14. The results indicate 38.88 steppe buzzard collisions per year with European honey buzzard the second most ‘at risk’ species with 2.04 collisions predicted per year. The refined model predicts black kite (0.85 collisions per year) and steppe eagle (0.77 collisions per year) collisions would be fewer than one each year.

Table 13: Collision Risk Modelling Results

Species	Season	Spring									Autumn									Cumulative Annual Totals	
	Location	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	Collisions per Year	Years per Collision
Black kite	No Avoidance	0.00	0.00	0.00	0.00	0.00	4.51	0.00	0.00	0.00	6.69	1.61	13.01	3.34	15.79	12.08	9.29	7.37	0.00	73.69	0.01
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.13	0.03	0.26	0.07	0.32	0.24	0.19	0.15	0.00	**1.48**	**0.68**
Booted eagle	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	0.74	3.40	1.93	0.00	0.00	1.70	0.00	0.00	8.79	0.11
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.07	0.04	0.00	0.00	0.03	0.00	0.00	**0.17**	**5.88**
Common kestrel	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.91	0.00	0.66	0.00	0.00	0.76	3.09	0.32
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.00	0.03	0.00	0.00	0.04	**0.16**	**6.25**
Eastern imperial eagle	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.96
	95 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**	**50.00**
Egyptian vulture	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.12	0.00	0.93	1.12	0.00	0.00	0.00	0.00	1.86	5.03	0.20
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.04	**0.10**	**10.00**
Eurasian sparrowhawk	No Avoidance	0.00	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.95	0.00	0.00	0.53	0.00	0.00	2.90	0.35
	98 % Avoidance	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.01	0.00	0.00	**0.06**	**18.18**
European honey buzzard	No Avoidance	3.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	113.96	0.00	7.38	0.00	12.54	35.96	0.00	7.31	2.77	183.02	0.01
	98 % Avoidance	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.28	0.00	0.15	0.00	0.25	0.72	0.00	0.15	0.06	**3.67**	**0.27**
Griffon vulture	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.59	0.12
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.43**	**2.33**
Hen harrier	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.81	0.55
	95 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.04**	**25.00**
Lesser kestrel	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	1.51	0.00	0.00	2.16	0.46
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.00	0.00	**0.11**	**9.09**
Lesser-spotted eagle	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.20	0.00	0.00	0.00	1.04	0.00	0.00	0.00	0.00	3.24	0.31
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	**0.06**	**16.67**
Levant sparrowhawk	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.51	1.96
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	**0.01**	**100.00**
Long-legged buzzard	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.00	2.09	0.00	4.36	3.14	8.89	4.53	0.58	0.99	0.87	26.37	0.04
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.04	0.00	0.09	0.06	0.18	0.09	0.01	0.02	0.02	**0.53**	**1.89**
Marsh harrier	No Avoidance	1.05	0.00	0.00	4.18	0.00	0.00	0.00	2.96	0.00	13.43	0.81	10.26	1.12	4.23	0.00	0.62	7.40	0.93	46.98	0.02
	98 % Avoidance	0.02	0.00	0.00	0.09	0.00	0.00	0.00	0.06	0.00	0.27	0.02	0.21	0.02	0.08	0.00	0.01	0.15	0.02	**0.95**	**1.06**
Montagu's harrier	No Avoidance	0.00	0.00	0.00	0.00	2.80	0.00	0.00	0.00	0.00	1.06	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	4.74	0.21
	98 % Avoidance	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	**0.10**	**10.53**
Osprey	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.93	1.08
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**	**50.00**
Pallid harrier	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.00	2.02	0.00	0.00	0.00	0.00	1.46	1.12	0.95	0.84	7.28	0.14
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.03	0.02	0.02	0.02	**0.15**	**6.67**

Species	Season	Spring									Autumn									Cumulative Annual Totals	
	Location	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9	Collisions per Year	Years per Collision
Purple heron	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.76	0.03
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.58**	**1.72**
Saker falcon	No Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.60	1.67
	98 % Avoidance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	**0.01**	**100.00**
Short-toed snake eagle	No Avoidance	0.00	0.00	0.00	1.12	0.00	1.61	0.00	3.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	6.89	0.15
	98 % Avoidance	0.00	0.00	0.00	0.02	0.00	0.03	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	**0.14**	**7.41**
Steppe buzzard	No Avoidance	0.00	0.65	0.75	2.69	0.85	13.58	0.00	2.54	0.75	957.43	15.94	224.65	52.77	560.84	789.17	63.96	367.86	99.13	3153.49	0.00
	98 % Avoidance	0.00	0.02	0.02	0.06	0.02	0.27	0.00	0.05	0.02	19.15	0.32	4.50	1.06	11.22	15.79	1.28	7.36	1.99	**63.08**	**0.02**
Steppe eagle	No Avoidance	0.00	0.00	2.72	3.26	2.05	0.79	0.00	0.00	0.00	10.48	3.37	8.73	3.49	8.80	4.21	1.29	2.20	1.94	53.32	0.02
	98 % Avoidance	0.00	0.00	0.06	0.07	0.04	0.02	0.00	0.00	0.00	0.21	0.07	0.17	0.07	0.18	0.08	0.03	0.04	0.04	**1.06**	**0.94**

Table 14: Adapted Collision Risk Modelling for the Autumn Survey Period

Species	Location	Autumn									Adapted Autumn Collisions per Year	Original Spring Collisions per Year	Collisions per Year	Years per Collision
		VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	VP9				
Black kite	No Avoidance	3.66	0.88	7.12	1.83	8.64	6.61	5.09	4.03	0.00	37.87	4.51	42.38	0.02
	98 % Avoidance	0.07	0.02	0.14	0.04	0.18	0.13	0.10	0.08	0.00	0.76	0.09	**0.85**	**1.18**
European honey buzzard	No Avoidance	62.38	0.00	4.04	0.00	6.86	19.68	0.00	4.00	1.52	98.49	3.10	101.58	0.01
	98 % Avoidance	1.25	0.00	0.08	0.00	0.14	0.39	0.00	0.08	0.03	1.98	0.06	**2.04**	**0.49**
Steppe buzzard	No Avoidance	587.73	9.78	137.90	32.39	344.28	484.44	39.26	225.81	60.85	1922.45	21.78	1944.23	0.00
	98 % Avoidance	11.75	0.20	2.76	0.65	6.88	9.69	0.79	4.51	1.22	38.45	0.44	**38.88**	**0.03**
Steppe eagle	No Avoidance	7.03	2.26	5.86	2.34	5.90	2.82	0.87	1.48	1.30	29.85	8.81	38.66	0.03
	98 % Avoidance	0.14	0.04	0.11	0.05	0.12	0.05	0.02	0.03	0.03	0.59	0.18	**0.77**	**1.30**

5.2 Constant Effort Survey Results

The constant effort surveys across the full survey period resulted in 6582 records of 68 species. The three most abundant species were steppe buzzard (1819 records), barn swallow (1231 records) and European bee-eater (1009 records). A summary of the records across the winter, spring and autumn survey periods are provided in Section 5.2.1 and Section 5.2.2. Constant effort survey results are also encompassed within the full target species and secondary species accounts which are provided in Section 5.5 and Section 5.6, respectively.

5.2.1 Constant Effort Survey Winter and Spring Periods

The constant effort surveys in winter and spring recorded 2452 individual birds of 57 species. Ten target species were recorded during this time, three of which were not observed within active VP surveys; common crane, golden eagle and peregrine falcon. Full target species accounts are provided in Section 5.5.

The most abundant species recorded during this period was barn swallow (707 records) followed by Temminck's lark (548 records). The peak day counts of birds occurred on 19 March 2017, when large mixed lark species flocks were observed, and 23 April 2017 which coincides with the peak count of barn swallow. The most notable 'secondary species' recorded was see-see partridge, which may confirm residency of this species within KSA, as such a separate account is included for this species (see Section 5.6.2). Full secondary species accounts are provided in Section 5.6.

5.2.2 Constant Effort Survey Autumn Period

The constant effort surveys in autumn recorded 4130 individual birds of 44 species. Six target species were recording during this time all of which were also recorded during active VP surveys. Steppe buzzard was the most abundant species recorded during constant effort surveys. In total 1809 steppe buzzards were observed outside of active VP surveys with a peak day count of 1100 steppe buzzards recorded early morning on 4 October 2017 at extreme distance (>10km) whilst travelling through the site to reach a specific VP location. Full target species accounts are provided in Section 5.5.

With the exception of steppe buzzard, European bee-eater was the most abundant species recorded at the development site during the autumn survey period with a total of 826 individuals observed and many heard but not directly sighted. Barn swallow (524 records), desert lark (239 records) and greater short-toed lark (110 records) make up the five species for which more than 100 records were made.

The most notable record during the autumn survey period was of a single little bustard on 8 October 2017. This is the first little bustard recorded in Saudi Arabia, as such a separate account is included for this species (Section 5.6.2).

5.3 Species-specific Survey Results

A proportion of planned surveys and associated travel through site was undertaken near-dawn and pre-dusk, to target crepuscular and nocturnal species. A single European nightjar on 17 September 2017 was the only crepuscular or nocturnal species directly observed during the full survey period. The presence of pharaoh eagle-owl was also confirmed through other evidence (pellets) during winter surveys.

Winter surveys were undertaken in January 2017 and identified multiple species thought likely to be resident within the development site. The only species recorded during the winter survey period which was not recorded during the spring or autumn survey periods was common crane. Full target and secondary species accounts, which detail which species are considered to be resident, are provided in Section 5.5 and 5.6 respectively.

Surveys and associated travel through the site near-dawn and pre-dusk identified target species using parts of the development site for roosting on the ground during both migration periods. This includes large numbers of steppe buzzards with smaller numbers of black kite, marsh harrier and steppe eagle also recorded on the ground, particularly during the early morning period. Further detail on roosting behaviour is captured in the full target species accounts (see Section 5.5).

5.4 Incidental Observations

Incidental observations of birds during planned VP surveys and travel around the site have been included within constant effort survey results (see Section 5.2).

Nine secondary species were recorded incidentally during remote monitoring coverage for mammal activity. The most notable species, pale rockfinch was only recorded by remote trail cameras, once, on 25 April 2017 until a pair were observed directly on 16 October 2017. Full secondary species accounts to date are provided in Section 5.6.

5.5 Target Species Accounts

Full species accounts for each target species to date are provided below. IUCN conservation status and global population trend are included for context (see Section 4.3).

5.5.1 Black kite

Conservation Status: *Least Concern* ***Population Trend*****:** *Unknown*

Across the full survey period 135 black kites were recorded within the development site. In spring a total of 1073 flight seconds were recorded with 315 seconds (29 %) at CRZ height band C. The remaining seconds were logged below collision risk height. In autumn a total of 32,254 flight seconds were recorded with 16,482 seconds (51 %) recorded at CRZ height band C.

Fifty-nine separate flight lines were logged with the most occurring at VP5 (11 flights). A peak count of 18 black kite was recorded on 26 September. Collison risk modelling predicted 1.48 collisions per year, which is the equivalent of a collision every 0.68 years. Refined collision risk modelling for black kite predicted 0.85 collisions per year, which is the equivalent of a collision every 1.18 years.

Three individuals were recorded outwith VP surveys on route to the site on 14 September 2017.

5.5.2 Booted eagle

Conservation Status: *Least Concern* ***Population Trend:*** *Unknown*

Seventeen booted eagle were recorded during the autumn survey period. The birds were recorded on 14 separate flight lines with ten occurring at collision height. A total of 4209 flight seconds were logged with 2801 seconds (67 %) at CRZ height. The peak day count of five occurred on 26 September 2017 and the most flights (five) were recorded from VP3. Collison risk modelling predicted 0.17 collisions per year, which is the equivalent of a collision every 5.88 years.

5.5.3 Common crane

Conservation Status: *Least Concern* ***Population Trend:*** *Increasing*

Three common cranes were observed at distance on 23 January 2017 during winter surveys. The birds were flying directly northwest through the centre of the site. The birds were flying directly and below collision risk height and although they were observed from distance it was determined the birds were within the view arc of VP5.

5.5.4 Common kestrel

Conservation Status: *Least Concern* ***Population Trend:*** *Decreasing*

Fourteen common kestrels were recorded during VP surveys in the spring period. Twelve flight lines of single birds were noted with two birds observed together on 25 March 2017. A total of 1773 flight seconds were logged, all below collision risk height, with 1376 seconds (78 %) within height band A. In the autumn survey period 53 flights of 59 individuals were recorded. A total of 6057 flight seconds were logged, with 89 % below CRZ (5413 seconds). Most autumn flights were recorded in the north of the site at VP1, VP2 and VP3 (11, seven and nine flights respectively). Collison risk modelling predicted 0.16 collisions per year, which is the equivalent of a collision every 6.25 years.

Twelve further records of common kestrel were noted during the constant effort surveys including sightings on three separate dates in winter. There was a particular pattern of activity surrounding the railway bridge to the west of the development site. It is considered likely that common kestrel is resident and breeds within the immediate vicinity of the development site.

5.5.5 Eastern imperial eagle

Conservation Status: *Vulnerable* ***Population Trend:*** *Decreasing*

Two juvenile eastern imperial eagle were recorded in the autumn survey period. The birds were recorded on 16 and 19 October 2017 from VP5 and VP3 respectively. A total of 404 flight seconds were recorded between the two birds with 307 seconds (76 %) occurring at CRZ height. Collison risk modelling predicted 0.02 collisions per year, which is the equivalent of a collision every 50 years.

5.5.6 Egyptian vulture

Conservation Status: *Endangered* ***Population Trend:*** *Decreasing*

Six Egyptian vulture were recorded individually during the autumn survey period. A total of 2606 flight seconds were logged with 1561 seconds (60 %) occurring at CRZ height. The six individuals were recorded between 19 September and 19 October 2017. On three occasions the Egyptian vultures were recorded migrating as part of large groups of mixed raptors, primarily with steppe buzzards. Collison risk modelling predicted 0.10 collisions per year, which is the equivalent of a collision every 10 years.

5.5.7 Eurasian hobby

Conservation Status: *Least Concern* ***Population Trend:*** *Decreasing*

Two Eurasian hobby were recorded separately in the autumn survey period. The individuals, both adults, were recorded on 16 September and 16 October 2017. One individual was recorded on the ground prior to a low and direct flight in band A. A total of 115 flight seconds were recorded, all below CRZ height band C. Eurasian hobby is the only target species recorded during the VP surveys with no time spent in height band C and therefore CRM was not undertaken for this species.

5.5.8 Eurasian sparrowhawk

Conservation Status: *Least Concern* ***Population Trend:*** *Stable*

A single female Eurasian sparrowhawk was recorded at CRZ height band C for 60 seconds on 12 April 2017 from VP3 in the spring survey period. Thirteen Eurasian sparrowhawk were recorded during the autumn VP surveys. A total of 2290 flight seconds were logged with 1687 seconds (74 %) at CRZ height. Sightings were spread across the site although the most flights were recorded from VP3 (three flights). Eurasian sparrowhawk were observed migrating with other raptors on three occasions. Collison risk modelling predicted 0.06 collisions per year, which is the equivalent of a collision every 18.18 years.

5.5.9 European honey buzzard

Conservation Status: *Least Concern* ***Population Trend:*** *Decreasing*

Three European honey buzzards were observed concurrently during the spring survey period on 20 April 2017 from VP1. In total 882 flight seconds were logged along a single flight line of which 465 flight seconds (53 %)

were within height band C. The additional 417 flight seconds were above collision risk height within height band D.

European honey buzzard was the second most abundant species recorded during the autumn survey period with a total of 184 individuals observed on 31 separate flight lines. A total of 97,854 flight seconds were logged with 68,789 seconds (70 %) occurring at CRZ height band C. Collison risk modelling predicted 3.67 collisions per year, which is the equivalent of a collision every 0.27 years. Refined collision risk modelling for European honey buzzard predicted 2.04 collisions per year, which is the equivalent of a collision every 0.49 years.

The peak day count occurred on 1 October 2017 when 77 European honey buzzard were recorded from VP1 during a single VP watch. On all occasions European honey buzzard were recorded migrating in proximity to steppe buzzard.

5.5.10 Golden eagle

A single golden eagle was recorded on the edge of the development site in the spring survey period. The individual was noted as an incidental record during a survey from VP5 as it was deemed to be outside the development site.

5.5.11 Griffon vulture

Conservation Status: *Least Concern* ***Population Trend:*** *Increasing*

Eight griffon vultures were recorded concurrently at VP9 on 27 April 2017. A total of 5184 flight seconds were logged of which 3803 seconds (73 %) were within CRZ height band C. The remaining flight seconds were in height band D. This is the only record of griffon vultures within the development site. Collison risk modelling predicted 0.43 collisions per year, which is the equivalent of a collision every 2.33 years.

5.5.12 Hen harrier

Conservation Status: *Least Concern* ***Population Trend:*** *Decreasing*

Four hen harriers were recorded during VP surveys across three separate flight lines in the spring survey period. The flights were recorded from VP5, VP8 and VP9. A total of 508 flight seconds were logged of which 303 seconds (77 %) were at height band A. Fifty-five seconds (11 %) were logged at CRZ height band C. Two more hen harriers were recorded separately in the spring survey period on 13 September and 9 October 2017. A total of 286 flight seconds were recorded with 138 seconds (48 %) at CRZ height. Collison risk modelling predicted collisions 0.04 per year, which is the equivalent of a collision every 20 years.

Two further hen harriers, an adult male (5 April 2017) and female (18 April 2017) were recorded during constant effort surveys whilst accessing the development site from the north-east near the quarry.

5.5.13 Lesser kestrel

Conservation Status: *Least Concern* ***Population Trend:*** *Stable*

Two lesser kestrels, an adult male and female were recorded together from VP5 on 11 April 2017 during the spring survey period. The flight line was recorded at height band A for 90 seconds, totalling 180 flight seconds for the birds. Twenty-seven lesser kestrel were recorded during the autumn survey period. Across 19 separate flights a total of 3649 flight seconds were logged of which 678 seconds (19 %) occurred at CRZ height band C. Fourteen lesser kestrel were recorded migrating south along the site plateau edge on 26 September 2017 from VP7. Collison risk modelling predicted 0.11 collisions per year, which is the equivalent of a collision every 9.09 years.

5.5.14 Lesser-spotted eagle

Conservation Status: *Least Concern* ***Population Trend:*** *Stable*

Three lesser-spotted eagles were recorded separately during the autumn survey period between 1 October and 5 October 2017. A total of 434 flight seconds were logged for the birds, all of which were at CRZ height band C. One individual was recorded migrating with a large group of other raptors, including steppe eagle and steppe buzzard from VP1, while another was observed being mobbed by a marsh harrier, also at VP1. Collison risk modelling predicted 0.06 collisions per year, which is the equivalent of a collision every 16.17 years.

5.5.15 Levant sparrowhawk

Conservation Status: *Least Concern* ***Population Trend:*** *Stable*

A single adult female Levant sparrowhawk was recorded from VP7 on 26 September 2017. The bird was recorded for 286 seconds with 197 seconds (69 %) at height band B prior to moving into band C and then out of sight. Photographs were used to confirm this record as it is the only Levant sparrowhawk to have been recorded within the development site. Collison risk modelling predicted collisions 0.02 per year, which is the equivalent of a collision every 100 years.

5.5.16 Long-legged buzzard

Conservation Status: *Least Concern* ***Population Trend:*** *Stable*

Three individual long-legged buzzards were recorded within the development site during the spring survey period. Two were recorded separately on 30 March 2017 at VP6. The third was observed from VP8. In total 225 flight seconds were logged, 105 seconds (47 %) were at collision risk height band C. Thirty-four long-legged buzzards were recorded on 20 separate flight lines during the autumn survey period. A total of 12,127 flight seconds were logged with 7807 seconds (64 %) at CRZ height band C. Most observations (14 flights) were made of long-legged buzzards directly associating with large groups of steppe buzzard on migration through the site. Collison risk modelling predicted 0.53 collisions per year, which is the equivalent of a collision every 1.89 years.

5.5.17 Marsh harrier

Conservation Status: *Least Concern* ***Population Trend:*** *Increasing*

Forty-two marsh harriers were recorded during VP surveys in spring. A total of 32 separate flight lines were logged totalling 6221 flight seconds. The majority of flight seconds in spring were recorded below collision risk height with 5172 seconds (83 %) across height band A and B. Half of the total 32 flight lines were logged from VP4. The peak count in spring (five individuals) was recorded from VP4 on 25 March 2017 when the peak day count of 22 individuals was observed on the same day.

During the autumn survey period a further 85 marsh harrier were recorded on 60 separate flight lines. A total of 20,122 flight seconds were recorded of which 11,577 seconds (58 %) were at CRZ height band C. Collison risk modelling predicted 0.95 collisions per year, which is the equivalent of a collision every 1.06 years.

Constant effort survey and incidental notes were taken for marsh harrier on three separate dates. A minimum of 20 further marsh harriers were observed on 25 March 2017 outside the site boundary from VP4. Although 22 individuals were recorded within the view arc of the active VP that morning further movement was visible in the distance to the west of the railway line c.1km outside the development site. Two further records of marsh harrier on 2 April and 12 April 2017 were noted whilst accessing the site from the northeast near to the quarry.

5.5.18 Montagu's harrier

Conservation Status: *Least Concern* ***Population Trend:*** *Decreasing*

Twenty Montagu's harriers were recorded within VP surveys during the spring survey period. A total of 16 flight lines were logged with 1743 flight seconds. A total of 1473 flight seconds (85 %) were noted below collision risk height at band A and B.

A similar number of Montagu's harriers were recorded in the autumn survey period with 24 recorded individually during VP surveys. A total of 3948 flight seconds were logged of which 3723 seconds (94 %) were below CRZ height in band A and B. Collison risk modelling predicted 0.10 collisions per year, which is the equivalent of a collision every 10.53 years.

Constant effort and incidental notes were taken for Montagu's harrier on two separate dates in the spring survey period. Two birds and another individual were recorded on 17 April and 15 April 2017, respectively, whilst accessing the site from the northeast near to the quarry. Four further Montagu's harrier were recorded in flight whilst accessing the development site near the quarry in the autumn survey period. Another individual was recorded on the ground within the development site boundary upon arrival to the site early morning on 17 September 2017.

5.5.19 Osprey

Conservation Status: *Least Concern* ***Population Trend:*** *Increasing*

A single adult osprey was recorded over the development site on 20 September 2017. The individual was recorded at CRZ height band C for 342 flight seconds at VP3. Collison risk modelling predicted 0.02 collisions per year, which is the equivalent of a collision every 50 years.

5.5.20 Pallid harrier

Conservation Status: *Near Threatened* ***Population Trend:*** *Decreasing*

Eighteen pallid harriers were recorded individually during spring VP surveys. A total of 1092 flight seconds were logged of which 942 seconds (86 %) were below CRZ in height bands A and B. Ninety-five pallid harriers were recorded during the autumn survey period across 91 flight lines. A total of 10,162 flight seconds were logged of which 8342 seconds (82 %) occurred below CRZ height in band A and B. Pallid harriers were recorded from every VP although the most flights were recorded from VP1, VP5 and VP6 (26, 13 and 14 flights respectively).

Twelve further pallid harriers were recorded during constant effort observations across the full survey period. Two pallid harriers were also recorded on each of two separate dates, 12 April and 25 April 2017 whilst accessing the development. Collison risk modelling predicted 0.15 collisions per year, which is the equivalent of a collision every 6.67 years.

5.5.21 Peregrine falcon

Conservation Status: *Least Concern* ***Population Trend:*** *Stable*

A single male peregrine falcon was recorded within the development site whilst travelling between VP5 and VP1 on 23 March 2017. The bird was observed briefly, flying below collision risk height.

5.5.22 Purple heron

Conservation Status: *Least Concern* ***Population Trend:*** *Decreasing*

A single flock of nineteen purple herons was recorded on 1 October 2017 from VP1. The flock was observed for 407 seconds which accounts for a combined total of 7733 seconds at CRZ height. Collison risk modelling predicted 0.58 collisions per year, which is the equivalent of a collision every 1.72 years.

5.5.23 Saker falcon

Conservation Status: *Endangered* ***Population Trend:*** *Decreasing*

A single saker falcon was recorded over the development site on 10 October 2017. The bird was observed in CRZ band C for 220 seconds from VP7. Collison risk modelling predicted 0.01 collisions per year, which is the equivalent of a collision every 100 years.

5.5.24 Short-toed snake eagle

Conservation Status: *Least Concern* ***Population Trend:*** *Stable*

Six short-toed snake eagles were recorded separately within the development site across the full survey period. Nine flight lines were recorded in spring constituting 1867 flight seconds, 857 seconds (46 %) were logged at collision risk height band C, with the remaining seconds below CRZ height. A single short-toed snake eagle was recorded during the autumn survey period at VP9 when a short flight (51 seconds) was logged in CRZ height band C. Collison risk modelling predicted 0.14 collisions per year, which is the equivalent of a collision every 7.41 years.

The highest number of flights were recorded from VP8 (four) although all four were of a single bird which perched on a meteorological mast between hunting bouts on April 19 2017. Two days previous on 17 April hunting behaviour was also noted at VP6.

5.5.25 Steppe buzzard

Conservation Status: *Least Concern* ***Population Trend:*** *Stable*

During the spring survey period 36 individual steppe buzzard were recorded on 17 flight lines. A total of 5304 flight seconds were logged of which 1736 seconds (33 %) were at collision risk height band C.

Steppe buzzard was the most abundant species recorded in the autumn period. A total of 5235 steppe buzzard were recorded during VP surveys, on 192 separate flight lines, often migrating in large groups. The largest single group, 355 steppe buzzard (not including other species), was observed from VP7 on 26 September 2017. A total of 2,122,921 flight seconds were logged for steppe buzzard in autumn, with 1,361,505 seconds (64 %) at CRZ height band C.

Steppe buzzards were recorded at all VP locations. Most flight activity was recorded from VP5 and VP6 (38 and 41 flights respectively) with least activity at VP2 (seven flights). This pattern of activity is reflected within the total number of steppe buzzards recorded from each VP in the autumn period; VP5 (1159 individuals) and VP6 (1201 individuals). Collison risk modelling predicted 63.08 collisions per year, which is the equivalent of a collision every 0.02 years. Refined collision risk modelling for steppe buzzard predicted 38.88 collisions per year, which is the equivalent of a collision every 0.03 years.

Over 1800 steppe buzzards have been recorded through the constant effort survey and incidental observations. The majority of these observations have been made whilst accessing the site and travelling to VP locations. Many of the observations have been of steppe buzzards on the ground early in the morning, which are presumed to have roosted within the development site overnight. Occasionally these birds were subsequently recorded during the VP survey and therefore there may be a small overlap in the overall numbers recorded. However, on the morning of 4 October 2017 two very large groups of an estimated 500 and 600 steppe buzzards were observed at extreme distance (>10km) prior to a VP survey at VP8. These 1100 birds were not recorded within the VP survey totals.

5.5.26 Steppe eagle

Conservation Status: *Endangered* ***Population Trend:*** *Decreasing*

Sixty-one steppe eagles were recorded across the full VP survey period. In spring, a total of 1823 flight seconds were logged with 1044 seconds (57 %) at CRZ height band C. In autumn 13,380 flight seconds were logged with 11,064 seconds (83 %) at CRZ height band C. Steppe eagle was recorded from every VP although the highest number of flights were recorded from VP1 and VP5 (eight and 14 flights, respectively). A peak count of seven steppe eagle was recorded during a single VP survey on 1 October 2017 from VP1. Collison risk modelling predicted 1.06 collisions per year, which is the equivalent of a collision every 0.94 years. Refined collision risk modelling for steppe eagle predicted 0.77 collisions per year, which is the equivalent of a collision every 1.3 years.

Fourteen steppe eagle were recorded through constant effort surveys. Six steppe eagle were recorded concurrently roosting on the ground in the northeast corner of the development site, spread between the quarry and within the development site itself, on 25 March 2017. Notably, steppe eagle was recorded throughout the full autumn survey period. Two birds were recorded roosting on the ground on the first morning on site and a single steppe eagle, also on the ground in the morning, was one of the last birds recorded in the autumn survey period.

5.6 Secondary Species Accounts

Table 15 combines the results of the constant effort surveys and incidental observations during winter and spring to provide full species accounts for all secondary (non-target) species. Scientific or Latin names, IUCN conservation statuses and population trends are provided separately in Appendix A.

Table 15: Secondary Species Accounts

Species	Species Account
Barn swallow	Barn swallow was recorded regularly during the migration survey periods. A peak day count of 192 individuals was observed on 23 April 2017. In total 707 individuals were recorded in spring, making this the most numerous species recorded in that survey season. A total of 524 individuals were recorded in the autumn survey period. This species is considered to be a long distance migrant on passage through the development site.
Bar-tailed lark	Bar-tailed lark was recorded on two separate dates in the winter survey period, 23 dates in spring and nine days in the autumn survey period. A peak count of 39 individuals was observed on 19 March 2017. This species is considered to be both an irruptive winter visitor and semi-resident within the development site.
Bimaculated lark	A single bimaculated lark was recorded on passage on 20 March 2017.
Black redstart	Singles of black redstart were recorded on two separate dates, one in the winter survey period and one in the spring survey period.
Blackcap	A single blackcap was recorded on 2 May 2017. This species is considered to be a long distance migrant on passage through the development site.
Black-eared wheatear	Black-eared wheatear was recorded on six separate dates in the spring survey period, with no more than two individuals observed on a single date. A single black-eared wheatear was recorded on 20 September 2017. This species is considered to be a long distance migrant on passage through the development site.
Blue-cheeked bee-eater	Blue-cheeked bee-eater was recorded on two separate dates during the spring survey period, with a peak count of two individuals on 1 May 2017. This species is considered to be a long distance migrant on passage through the development site.
Brown-necked raven	Brown-necked raven was recorded on a single date in the winter survey period and on eight separate dates in both the spring and autumn survey periods. This species is considered likely to be resident within the vicinity of the development site.

Species	Species Account
Common hoopoe	Common hoopoe was recorded on passage on four separate dates in the spring survey period and two dates in autumn, with no more than two individuals observed on a single date. This species is considered to be a short distance migrant on passage through the development site.
Common quail	Common quail was recorded on four separate dates in the autumn survey period. A peak count of two individuals, using empty Bedouin-style shelters for cover, was recorded on 18 September 2017. This species is considered to be a long distance migrant on passage through the development site.
Common redstart	Common redstart was recorded on two separate dates in the spring survey period. Both observations were of single birds. This species is considered to be a long distance migrant on passage through the development site.
Common swift	Common swift was recorded on seven separate dates in the spring survey period. A peak count of 11 individuals was observed on 14 March 2017. This species is considered to be a long distance migrant on passage through the development site.
Common whitethroat	Common whitethroat was recorded on two separate dates in the spring survey period. A peak count of two individuals was observed on 23 April 2017. This species is considered to be a long distance migrant on passage through the development site.
Cream-coloured courser	Cream-coloured courser was recorded on eight separate dates in spring and three dates in the autumn survey period. A peak count of seven individuals was observed on 20 March 2017. An old cream-coloured courser carcass was found within the development site on 12 March 2017. This species is considered to be a short distance migrant on passage through the development site although it is possible a small number may breed in the vicinity of the development site.
Crested lark	Crested lark was recorded on 41 separate dates in the full survey period. A peak count of 28 individuals was observed on 22 October 2017. This species is considered likely to be semi-resident within the development site.
Desert finch	Two desert finch were recorded on 3 April 2017. This species is resident in the wider area.
Desert lark	Desert lark was recorded every day of the winter and autumn survey periods and on 27 separate dates in the spring survey period. A peak count of 31 individuals was observed on 22 October 2017. Two pairs were seen building nests separately, one of which had laid two eggs by 2 May 2017. This species is apparently resident within the development site.
Desert wheatear	Desert wheatear was recorded on three separate dates in the winter survey period and eight separate dates in both the spring and autumn survey periods. A peak count of four individuals was observed on 23 March 2017. This species is considered to be a short distance migrant on passage through the development site with some individuals wintering on site.
Eurasian collared dove	Eurasian collared dove was recorded on three separate dates in the spring survey period. A peak count of ten individuals was observed on 23 March 2017. This species is resident within the wider area.
Eurasian crag martin	A single Eurasian crag martin was recorded on 24 April 2017. This species is considered to be a long distance migrant on passage through the development site.

Species	Species Account
Eurasian reed warbler	A single Eurasian reed warbler was recorded on 11 September 2017 in a dry wadi area at the southern edge of the site. This species is considered to be a long distance migrant on passage through the development site.
Eurasian skylark	Two Eurasian skylark were recorded adjacent to VP8 on 25 September 2017. This species is considered to be a long distance migrant on passage through the development site.
Eurasian wryneck	A single wryneck was recorded on 3 April 2017. This species is considered to be a long distance migrant on passage through the development site.
European bee-eater	European bee-eater was recorded on ten separate dates at the end of the spring survey period. A peak spring count of 85 individuals was observed on 27 April 2017. European bee-eater was the most abundant secondary species in the autumn survey period with over 826 individuals recorded over 20 separate days. This species is considered to be a long distance migrant on passage through the development site.
European nightjar	A single European nightjar was flushed whilst travelling through the development site on 17 September 2017. This species is considered to be a long distance migrant on passage through the development site.
European roller	Two European rollers were recorded separately during the autumn survey period on 12 and 26 September 2017. Both observations were made of birds on the ground with the later sighting immediately prior to dusk. This species is considered to be a long distance migrant on passage through the development site.
Finsch's wheatear	Single Finsch's wheatears were recorded on 13 April and 8 October 2017. This species is considered to be a short distance migrant on passage through the development site.
Greater hoopoe-lark	Greater hoopoe-lark was recorded on 49 separate dates across the full survey period. A peak day count of six individuals was recorded twice, on 25 March and 22 October 2017. This species is apparently resident within the development site and was regularly observed singing and displaying in spring.
Greater short-toed lark	Greater short-toed lark was recorded, presumably on passage, on nine separate dates in spring and eight separate dates in the autumn survey period. A peak count of approximately 100 individuals amongst several mixed lark flocks was observed on 19 March 2017.
House sparrow	House sparrow was recorded on two separate dates in spring and five separate dates in the autumn survey period. A peak count of 28 individuals was observed on 17 October 2017. This species is apparently resident in the vicinity of the development site.
Isabelline wheatear	Isabelline wheatear was recorded on passage on ten separate dates in the spring survey period and two dates in autumn. A peak count of three individuals was observed on 20 March 2017. This species is considered to be a short distance migrant on passage through the development site.
Little bustard	See Section 5.6.1.
Namaqua dove	Namaqua doves were recorded on two separate dates in the autumn survey period. Two individuals were recorded together on 18 October 2017. This species is resident in the wider area.

Species	Species Account
Northern house martin	Northern house martin was recorded on six separate dates at the end of the spring survey period and three dates in the autumn survey period. A peak count of approximately 100 individuals in a single flock was observed on 1 May 2017. This species is considered to be a long distance migrant on passage through the development site.
Northern wheatear	Northern wheatear was recorded on 16 separate dates in the spring survey period and four dates in autumn. A peak count of six individuals was observed on 23 April 2017. An individual showing characteristics of 'Greenland' wheatear (*Oenanthe oenanthe leucorhoa*) was recorded on 18 April 2017. This species is considered to be a long distance migrant on passage through the development site.
Pale crag martin	Pale crag martin was recorded on eight separate dates, one in both winter and spring survey periods and six in autumn. A peak count of 3 individuals was observed on 26 March and 3 October 2017. This species may breed along the edge of the site plateau to the north of the development site.
Pale rockfinch	A single pale rockfinch was recorded on the trail camera on 25 April. Two individuals were also recorded on 16 October 2017. This species is likely to be a short distance migrant on passage through the development site.
Pharaoh eagle-owl	Pharaoh eagle-owl pellets were found on the development site on two separate dates in the winter survey period. A corpse was also discovered by the roadside approximately 6 km from the development site (29°54'35.09"N 39°49'17.01"E) on 23 January 2017. This species is likely to be resident within the development site although records are limited due to site-specific issues that resulted in a lack of nocturnal surveys.
Pied wheatear	Pied wheatear was recorded on two separate dates in the spring survey period and on one date in autumn. A peak count of two individuals was observed on 23 April 2017. This species is considered to be a long distance migrant on passage through the development site.
Red-backed shrike	Red-backed shrike was recorded on four separate dates at the end of the spring survey period and single date in autumn, 11 September 2017. All sightings were of single birds. This species is considered to be a long distance migrant on passage through the development site.
Red-rumped swallow	Red-rumped swallow was recorded on four separate dates in the spring survey period and a single date in the autumn survey period. A peak count of six individuals was observed on 18 April 2017. This species is considered to be a long distance migrant on passage through the development site.
Red-throated pipit	Red-throated pipit was recorded on three separate dates in both the spring and autumn survey periods. A peak count of 26 red-throated pipits was made on 16 October 2017. This species is considered to be a long distance migrant on passage through the development site.
Sand martin	Sand martin was recorded on three separate dates in spring and 11 dates in the autumn survey period. A peak count of 12 individuals was observed on 20 September 2017. This species is considered to be a long distance migrant on passage through the development site.
Sandgrouse sp.	Three sandgrouse sp. were recorded at distance on 16 October 2017. Due to heat haze and distance species could not be determined.

Species	Species Account
See-see partridge	See Section 5.6.2.
Spanish sparrow	Spanish sparrow was recorded on three separate dates in the spring survey period. A peak count of 16 individuals was observed on 23 April 2017, including a flock of 14 birds. This species is considered to be a long distance migrant on passage through the development site.
Tawny pipit	Two tawny pipits were recorded on 29 March 2017. This species is considered to be a long distance migrant on passage through the development site.
Temminck's lark	Temminck's lark was recorded on 29 separate dates across the full survey period. A peak count of 139 individuals was observed on 14 March 2017. This species is considered to be both an irruptive winter visitor and semi-resident within the development site.
Tree pipit	Two tree pipits were recorded on 2 May 2017. This species is considered to be a long distance migrant on passage through the development site.
Trumpeter finch	Trumpeter finch was recorded on 15 separate dates in the spring survey period. There was a single autumn record of eight individuals on 9 October. A peak count of ten individuals was observed on 13 April 2017. This species is considered to be resident in the vicinity of the development site.
Water pipit	A single water pipit, likely to be on passage, was recorded on 5 April 2017.
Western yellow wagtail	Western yellow wagtail was recorded on seven separate dates in the spring survey period and three dates in autumn, with no more than five individuals observed on a single date. This species is considered to be a long distance migrant on passage through the development site.
Whinchat	Whinchat was recorded on two separate dates in the spring survey period. A peak count of two individuals was observed on 18 April 2017. This species is considered to be a long distance migrant on passage through the development site.
White wagtail	Single white wagtails were recorded, presumably on passage, on 21 March and 18 October.
White-crowned wheatear	White-crowned wheatear was recorded on 16 separate dates across the full survey period. A peak count of seven individuals was observed on 22 January 2017. This species is apparently resident within the development site.
Willow warbler	Willow warbler was recorded on three separate dates at the end of the spring survey period. A peak count of six individuals was observed on 23 April 2017. The majority of birds showed characteristics of 'northern' willow warbler (*Phylloscopus trochilus acredula*). This species is considered to be a long distance migrant on passage through the development site.
White winged-tern	A single flock of 72 white-winged tern, presumably on passage, was recorded over the development site on 17 September 2017.
Woodchat shrike	Woodchat shrike was recorded on three separate dates at the end of the spring survey period. All sightings were of single birds. This species is considered to be a long distance migrant on passage through the development site.

5.6.1 Little bustard

An adult male little bustard was recorded on the morning of 8 October 2017 at VP3. The bird flew low, directly past the observer, and continued out of sight.

This species is not on the list of birds occurring in the Kingdom of Saudi Arabia and according to distribution maps does not occur in the area (Avibase, 2017). This sighting has been confirmed as a first for the Kingdom by a resident expert (Babbington Pers. Comm. 10 October 2017).

5.6.2 See-See partridge

See-see partridge was recorded on two separate dates in the spring survey period. Four individuals, including a calling male, were observed on 23 April 2017 and single bird was heard calling on 1 May 2017.

At the time the sightings were made this species was not on the list of birds occurring in the Kingdom of Saudi Arabia and according to distribution maps did not occur in the area. However, there have been a small number of sightings of see-see partridge in the Harrat al-Harrah region and in eastern Jordan in the 1990s (Jennings, 2010). The records within the development site are the first confirmed records for over 20 years and are likely to confirm presence of see-see partridge as a resident species in KSA. As a result of these sightings see-see partridge has since been added to the list of birds occurring in KSA (Avibase, 2017).

Photograph 1: Calling male see-see partridge

5.7 Dawmat al Jandl Wetland IBA

A total of 124 species were recorded within the Dawmat al Jandl Wetland IBA during sixteen visits to the IBA. Fifty-two of the species noted were also recorded within the development site, including eleven target species raptors. Over 200 Eurasian coot were recorded during the winter visit which is in line with the results of the desk-based study indicating presence of the species throughout the winter period. White-winged tern, noted online as being present in good numbers during late spring, was recorded at the IBA on four visits during the spring survey period, with a peak count of ten recorded on 11 April 2017. A flock of over 300 white-winged terns was observed on 30 September 2017 at the main reservoir within the IBA.

The most numerous wader species were Kentish plover (peak count of over 200 individuals on 7 October 2017), black-winged stilt (105 individuals on 11 April 2017) and little stint (a maximum of 60 individuals on 29 April 2017). Other notable records include ten white storks on 28 March 2017 with further peak counts of 20 cattle egrets and 16 little egrets on 29 April 2017. Steppe buzzard was the most numerous raptor with over 215 individuals on 23 September 2017. Species accounts for all 124 species recorded are provided in Table 16.

Table 16: Species accounts for species recorded at the Dawmat al Jandl Wetland IBA

Species	Species Account
African collared dove	A single African collared dove was observed with a group of Eurasian collared doves on 30 September 2017.
Armenian gull	A single Armenian gull was recorded on 28 March 2017.
Bar-tailed lark	A pair of bar-tailed lark were recorded on 7 October 2017.
Barn swallow	Barn swallow was recorded on seven separate dates in the spring survey period and all visits during the autumn survey period. Peak counts of at least 300 individuals were observed on 16 March and 26 April 2017.
Black kite	A single black kite was recorded on 26 April 2017 in the spring survey period. Black kites were recorded on four separate dates in the autumn survey period with a peak count of 13 on 23 September 2017.
Black-crowned night heron	Four black-crowned night heron were recorded on 29 April 2017.
Black-eared wheatear	A single black-eared wheatear was recorded on 26 April 2017.
Black-headed gull	Black-headed gull was recorded on five separate dates in the spring survey period. A peak count of 15 individuals was observed on 29 April 2017.
Black-necked grebe	At least 70 black-necked grebes were observed on 27 January 2017. Black-necked grebes were also recorded on two separate dates in the autumn survey period with a peak count of four on 21 October 2017.
Black-winged stilt	Black-winged stilt was recorded on every visit of the spring survey period. A peak count of 105 individuals was observed on 11 April 2017. Black-winged stilts were also present during the early autumn period with a peak and final count on 16 September 2017.
Blue-cheeked bee-eater	Blue-cheeked bee-eater was recorded on two separate dates in the spring survey period. A peak count of four individuals was observed on 29 April 2017.
Blackcap	Blackcap was recorded on two separate dates in the autumn survey period with a peak count of three individuals on 23 September 2017.
Booted eagle	Single booted eagles were recorded on 26 April and 16 September 2017.
Broad-billed sandpiper	A single broad-billed sandpiper was recorded on 11 April 2017.
Cattle egret	A flock of 20 cattle egrets was recorded on 29 April 2017.
Citrine wagtail	Citrine wagtail was recorded on three dates in the spring survey period; all observations were of single birds. Similarly, citrine wagtails were recorded on three separate dates in the autumn survey period with a peak count of four on 7 October 2017.
Common chiffchaff	Two common chiffchaffs were recorded on 29 April 2017. Common chiffchaffs were recorded on four separate dates in the autumn survey season. A peak count of five was recorded on 9 September 2017.
Common coot	Common coot was recorded on 27 January and 16 March 2017. A peak count of approximately 200 individuals was observed on 27 January 2017.
Common hoopoe	Common hoopoe was recorded on three separate dates during the autumn survey period. A peak count of eight was observed on 7 October 2017.
Common kestrel	Two common kestrel were recorded on 7 October 2017.

Species	Species Account
Common moorhen	Common moorhen was recorded on three separate dates in the spring survey period and five dates in the autumn survey period. A peak count of six individuals was observed on 23 September and 21 October 2017.
Common redshank	Common redshank was recorded on seven separate dates in the survey period. A peak count of 20 individuals was observed on 27 January 2017.
Common redstart	Common redstart was recorded on two dates in the spring survey period; both observations were of single birds.
Common ringed plover	Common ringed plover was recorded on thirteen separate dates in the survey period. A peak count of 60 individuals was observed on 21 October 2017.
Common sandpiper	Common sandpiper was recorded on seven separate dates in the survey period. A peak count of 14 individuals was observed on 19 April 2017. Common sandpiper was recorded on two dates in the autumn survey period with two individuals noted on 9 September 2017.
Common snipe	Common snipe was recorded on four separate dates across the full survey period. A peak count of two individuals was observed on 27 January and 7 October 2017.
Common tern	A single common tern was recorded on 28 March 2017.
Common whitethroat	Common whitethroat was recorded twice in the autumn survey period.
Crested lark	Crested lark was recorded on five separate dates in the spring survey period and during every visit of the autumn survey period. A peak count of 32 occurred on 16 September 2017.
Curlew sandpiper	Curlew sandpiper was recorded on three separate dates in the spring survey period and two separate dates in the autumn period. A peak count of four individuals was observed on 26 April 2017.
Desert finch	Desert finch was recorded on four separate dates across the full survey period. A peak count of five individuals was observed on 27 January 2017.
Desert lark	Desert lark was recorded on two separate dates during the autumn survey period with a peak count of 20 on 7 October 2017.
Desert wheatear	Two desert wheatear were observed on 21 October 2017.
Dunlin	Dunlin was recorded on ten separate dates across the full survey period. A peak count of 30 individuals was observed on 27 January and 21 October 2017.
Eastern olivaceous warbler	A single eastern olivaceous warbler was recorded on 19 April 2017 in the spring survey period. Eastern olivaceous warbler was recorded on three separate dates in the autumn survey period with a peak count of three individuals on 7 October 2017.
Eurasian collared dove	Eurasian collared dove is a common resident species and occurred regularly at the IBA.
Eurasian crag martin	Ten Eurasian crag martins were recorded on 28 March 2017.
Eurasian reed warbler	Three Eurasian reed warblers were recorded on 19 April 2017.
Eurasian spoonbill	Four Eurasian spoonbills were recorded on 4 April 2017 with a single individual recorded on 30 September 2017.
Eurasian teal	A single Eurasian teal was recorded on 26 April 2017.

Species	Species Account
European bee-eater	European bee-eater was recorded on two separate dates in the spring survey period and four separate dates in the autumn survey period. A peak count of 30 individuals was observed on 29 April 2017.
European honey buzzard	A single European honey buzzard was recorded on 26 April 2017.
European roller	A single European roller was recorded on 16 September 2017.
European turtle dove	Two European turtle dove were recorded on 30 September 2017.
Ferruginous duck	Five ferruginous duck were recorded on 16 September 2017.
Garganey	Garganey was recorded on two separate dates in the spring survey period and three dates in the autumn period. A peak count of ten individuals was observed on 30 September 2017.
Glossy ibis	A single glossy ibis was recorded on 16 September 2017.
Great cormorant	A single great cormorant was recorded on 4 April 2017.
Great reed warbler	A great reed warbler was recorded on 9 September 2017.
Great white egret	Great white egret was recorded on three separate dates in the autumn survey period with a peak count of two on 21 October 2017.
Greater hoopoe lark	Greater hoopoe lark was recorded on three separate dates in the autumn survey period with a peak count of six on 7 October 2017.
Greater sandplover	Greater sandplover was recorded on two separate dates in the spring survey period. A peak count of two individuals was observed on 26 April 2017.
Greater short-toed lark	Greater short-toed larks were observed on five separate dates across the autumn survey season. A peak count of twelve was recorded on 16 September 2017.
Green sandpiper	Green sandpiper was recorded on five separate dates in the spring survey period and four dates during the autumn survey period. A peak count of 12 individuals was observed on 28 March 2017.
Greenshank	Greenshank was recorded on four separate dates in the spring survey period and three separate dates in the autumn survey period. A peak count of two individuals was observed on 28 March and 16 September 2017.
Grey heron	Grey heron was recorded on two separate dates in the spring survey period and three dates in the autumn survey period. A peak count of 12 individuals was observed on 19 April 2017.
Gull-billed tern	Gull-billed tern was recorded on two separate dates in the spring survey period and a single date in the autumn survey period. A peak count of 11 individuals was observed on 28 March 2017.
House sparrow	House sparrow is a common resident species and occurred regularly at the IBA.
Isabelline shrike	Isabelline shrike was recorded on two dates in the spring survey period and two dates in the autumn survey period, all observations were of single birds.
Isabelline wheatear	Isabelline wheatear was recorded on two separate dates in the autumn survey period. Two individuals were recorded on 7 October 2017.
Kentish plover	Kentish plover was recorded on every visit made in the survey period with the exception of one when the main reservoir was not accessible. A peak count over 200 individuals was recorded on 7 October 2017.

Species	Species Account
Laughing dove	Laughing dove is a common resident species and occurred regularly at the IBA.
Lesser whitethroat	Lesser whitethroats were observed on every visit in the autumn survey period. A peak count of four was recorded on 30 September 2017.
Little bittern	Two little bitterns were recorded on 29 April 2017.
Little egret	Little egret was recorded on four separate dates in the spring survey period and five dates in the autumn survey period. A peak count of 16 individuals was observed on 29 April 2017.
Little grebe	Little grebes were recorded throughout the autumn period with a peak count of over one hundred on 9 September. Local hunters were observed shooting little grebe at the main reservoir within the IBA.
Little ringed plover	Little ringed plovers were observed on three separate dates towards the end of the autumn survey period. A peak count of five individuals was recorded on 30 September and 21 October 2017.
Little stint	Little stint was recorded on every visit made across the full survey period. A peak count of approximately 60 individuals was made on 29 April 2017.
Long-legged buzzard	A single long-legged buzzard was recorded on 16 March in the spring survey period. Long-legged buzzards were record on two separate dates during the autumn survey period.
Mallard	A dead mallard was found on 30 September considered likely to have been shot by hunters.
Marsh harrier	Two marsh harriers were recorded on 29 April 2017 during the spring survey period. Marsh harrier were recorded on three separate dates in the autumn survey period with a peak count of five on 30 September 2017.
Marsh sandpiper	Marsh sandpiper was recorded on nine separate dates in the full survey period. A peak count of three individuals was observed on 16 September and 7 October 2017.
Masked shrike	Two masked shrike were recorded on 30 September 2017.
Montagu's harrier	Montagu's harrier was recorded on three separate dates during the autumn survey period, all observations were of single birds.
Namaqua dove	Namaqua dove was recorded on three separate dates in the autumn survey period. A peak count of five Namaqua dove was recorded on 30 September 2017.
Northern house martin	Northern house martin was recorded on three separate dates in the spring survey period and four dates in the autumn survey period. A peak count of 30 individuals was observed on 26 April 2017.
Northern pintail	Northern pintail were recorded on two separate dates during the autumn survey period. A minimum of ten individuals were recorded on 30 September 2017.
Northern shoveler	Northern shoveler was recorded on two separate dates in the spring survey period. A peak count of 25 individuals was observed on 11 April 2017.
Northern wheatear	Northern wheatear was recorded on two separate dates in the spring survey period and three separate dates in the autumn survey period. A peak count of five individuals was observed on 16 September 2017.

Species	Species Account
Ortolan bunting	A single ortolan bunting was recorded on 26 April 2017.
Osprey	Osprey was recorded on two dates in the spring survey period; both observations were of single birds.
Pale crag martin	Pale crag martin were regularly recorded at the IBA throughout the full survey period.
Pallid harrier	Pallid harrier was recorded on two separate dates in the spring survey period. A peak count of two individuals was observed on 8 April 2017.
Pallid swift	A single pallid swift was recorded on 29 April 2017 in the spring survey period with four recorded in the autumn across two separate dates.
Pied avocet	Single pied avocets were recorded on 30 September and 7 October 2017.
Pied wheatear	Two pied wheatear were recorded on 7 October 2017.
Purple heron	A single purple heron was recorded on three separate dates between 30 September and 21 October 2017.
Red-backed shrike	Red-backed shrikes were observed on every visit of the autumn survey period, a peak count of 12 was recorded on 7 October 2017.
Red-necked phalarope	Red-necked phalarope was recorded on two separate dates in the spring survey period and two separate dates in the autumn survey period. A peak count of three individuals was observed on 26 April and 16 September 2017.
Red-rumped swallow	Two red-rumped swallows were recorded on 4 April in the spring survey period. Five were recorded in the autumn survey period between 30 September and 7 October 2017.
Red-throated pipit	Red-throated pipit was recorded on two separate dates in the spring survey period and a single date in the autumn survey period. A peak count of 60 individuals was observed on 11 April 2017.
Ruff	Ruff was recorded on 14 separate dates across the full survey period. A peak count of 40 individuals was observed on 28 March 2017.
Sand martin	Sand martin was recorded on five separate dates in the spring survey period and on all visits during the autumn survey period. A peak of a minimum of two hundred individuals was observed on 11 April 2017.
Sanderling	Five sanderling were observed on 30 September 2017.
Siberian stonechat	A single Siberian stonechat was recorded on 21 October 2017.
Slender-billed gull	Slender-billed gull was recorded on three separate dates in the spring survey period and a single date in the autumn survey period. A peak count of 16 individuals was observed on 19 April 2017.
Southern grey shrike	A single southern grey shrike was observed on 30 September 2017.
Spotted crake	A dead spotted crake was found on the road adjacent to an area of reed beds on 30 September 2017.
Spotted flycatcher	Spotted flycatcher was recorded on two dates in the spring survey period and three in autumn period. A peak count of three individuals was recorded on 23 September 2017.
Spotted redshank	Spotted redshank was recorded on four dates in the spring survey period and two dates in the autumn survey period. No more than five individuals were observed on a single date.

Species	Species Account
Spur-winged lapwing	Spur-winged lapwing was recorded on five dates in the spring survey period and three dates in the autumn survey period. A peak count of six individuals was recorded on 30 September 2017
Squacco heron	Squacco heron was recorded on four dates in the spring survey period. A peak count of 12 individuals was observed on 29 April 2017. A single individual was recorded in the autumn on 9 September 2017.
Steppe buzzard	A peak of over 215 steppe buzzard were observed on 23 September 2017. Steppe buzzard was recorded on five separate dates in the autumn survey period.
Steppe eagle	A single steppe eagle was recorded on 8 April 2017 and two were recorded on 30 September 2017.
Tawny pipit	Two tawny pipit were recorded on 21 October 2017.
Temminck's stint	Temminck's stint was recorded on three dates in the spring survey period and a single date in the autumn survey period. A peak count of three individuals was observed on 28 March 2017.
Terek sandpiper	Three terek sandpiper were recorded between 9 September and 16 September 2017.
Tree pipit	Tree pipit was recorded on three separate dates in the autumn. A peak count of three individuals was recorded on 30 September 2017.
Trumpeter finch	Thirty-five trumpeter finches were recorded on 28 March 2017 in the spring. Only two were recorded in autumn on 23 September 2017.
Turkestan shrike	A single Turkestan shrike was recorded on 29 April 2017.
Water pipit	A single water pipit was recorded on 28 March 2017.
Water rail	A single water rail was recorded on 19 April 2017 and another on 23 September 2017.
Western yellow wagtail	Western yellow wagtail was recorded on six dates in the spring survey period and during all visits in autumn. A peak count of 80 individuals was observed on 29 April 2017.
Whinchat	A single whinchat was recorded on 29 April 2017. Two were recorded on 9 September 2017.
White stork	White stork was recorded on two separate dates in the spring survey period. A peak count of ten individuals was observed on 28 March 2017.
White wagtail	White wagtail was recorded on two separate dates in the spring survey period and three in the autumn survey period. A minimum peak count of 40 individuals was observed on 21 October 2017.
White-cheeked bulbul	White-cheeked bulbul is a common resident species and occurred regularly.
White-tailed lapwing	Two white-tailed lapwing were recorded on 30 September 2017.
White-winged tern	White-winged tern was recorded on four dates in the spring survey period and three in the autumn survey period. A flock of over three hundred individuals was observed on 30 September 2017 at the main reservoir within the IBA.

Species	Species Account
Willow warbler	Willow warbler was recorded on two separate dates in the spring survey period. A single willow warbler was recorded during the autumn period on 30 September 2017. A peak count of seven individuals was observed on 26 April 2017.
Wood sandpiper	Wood sandpiper was recorded on five separate dates in the spring survey period and three dates in the autumn. A peak count of seven individuals was observed on 7 October 2017.
Wood warbler	A single wood warbler was recorded on 26 April 2017.
Woodchat shrike	A single woodchat shrike was recorded on 19 April 2017 in the spring survey period. Woodchat shrike were recorded on four separate dates in the autumn survey period. Eight individuals were observed in the vicinity of the IBA on 30 September 2017.
Yellow-legged gull	Yellow-legged gull was recorded on four separate dates in the spring survey period. A peak count of five individuals was observed on 26 April 2017.

6. Summary

Migratory, breeding and wintering ornithological surveys have been completed at the proposed Dumat al Jandal Wind Energy Park. A combination of VP survey effort across two migrations seasons, spring and autumn 2017, and constant effort surveys were undertaken to achieve robust coverage of the development site. Upon completion of the surveys detailed data analysis, including Collision Risk Modelling, has been undertaken.

Over 450 hours of VP survey were undertaken during migration periods across nine separate VP locations to provide sufficient coverage of the proposed turbine layout. A total of 6160 target species individuals of 23 species were recorded during the survey which generated a total of 759 separate flight lines (Figures TB18:1-16, TB19:1-16). A further three target species were observed through constant effort surveys observations (see Section 5.2).

The most abundant target species recorded was steppe buzzard (5271 individuals, 209 flights), which is reflected within the Collision Risk Modelling as the most ‘at risk’ species. A worst-case scenario model predicted 63.08 collisions each year at the development site, with a more refined model predicting 38.88 collisions per year. More than one hundred individuals were recorded of the following four target species (in addition to steppe buzzard): European honey buzzard (187 individuals recorded and 33 flight lines); black kite (132 individuals and 59 flight lines); marsh harrier (127 individuals and 92 flight lines); and pallid harrier (113 individuals and 109 flight lines). Steppe buzzard (see above), European honey buzzard (3.67 collisions per year), black kite (1.48 collisions per year) and steppe eagle (1.06 collisions per year) make up the four species for which worst-case scenario modelling predicted more than a single collision each year. For the remaining target species fewer than one collision per year was predicted.

Three of the target species recorded within the development site are listed as ‘Endangered’ by the IUCN (2017); Egyptian vulture (six individuals), saker falcon (one individual) and steppe eagle (75 individuals, including constant effort survey records). Refined collision risk modelling predicted 0.77 collisions per year for steppe eagle, which is equivalent to a collision every 1.3 years. For Egyptian vulture and saker 0.10 and 0.01 collisions per year were predicted.

A significant difference in the number of target species migrants is notable between the two migration seasons. In spring 181 target species individuals of 14 species were recorded, in autumn 5979 target species individuals of 23 species were recorded. By far the most frequently recorded and abundant species was steppe buzzard (5271 individuals) and many of the other raptor species were recorded migrating alongside or mixed in with large groups of this species. Steppe buzzards were regularly recorded on the ground early morning and are presumed to have roosted within the development site, steppe eagle, black kite and marsh harrier were also recorded in this manner.

The migration activity in the autumn and spring seasons covered widespread areas across the development site (Figures TB18:16 & TB19:16). Target species activity during the spring period was most frequently recorded across the four southerly VPs within the development site at VP4, VP5, VP6 and VP8 where 70 % of all flights were recorded. Activity in the autumn migration season was widely distributed, large numbers of birds were recorded right across the development site. The spatial patterns in activity may relate to the location of surveyors on key migration days, and may also be dependent on date and weather conditions such as wind direction. To what extent this has influenced spatial results cannot be determined although the back-to-back VP at VP2 and VP3 provides an example of this. A total of 51 target species individuals were recorded from VP2 during the autumn survey period with 431 recorded from VP3, both VPs are undertaken from the exact same location.

Nonetheless, there were clear patterns in movement during the autumn migration season, which appear distinctly different to those focussed within the south of the site in spring. Target species birds in autumn apparently used the edge of the site plateau in the north where the steep drop off to the ‘basin’ below leads to the development of thermals. This generalised flight path runs from the eastern edge of VP1 in the north of the site, following the north to south orientated site edge past VP2/VP3 down into the funnel-like bottleneck at the southern extent of the basin. This area sits directly north of the centre of the development site. Birds were observed moving directly south over the development site from many locations along this edge, however, most flight activity was observed in the centre of the site as birds moved south upon hitting this basin ‘bottleneck’ north of VP5 and VP6. This generalised flight path is reflected in the spatial distribution results as activity was most frequently recorded at VP1, the northern extent of the plateau edge, and VP5 and VP6, where most birds left the site edge and flew south across the site. Almost two thirds of flight activity in the autumn survey period (3859 individuals, 65 %) was recorded from these three VPs.

A total of 84 species were recorded on-site during the full survey period. The two most notable secondary species, little bustard and see-see partridge are nationally-significant records. These represent the first record of little bustard in KSA and the first confirmed record of residency for see-see partridge in KSA. There is a small number of resident species within the development site, seven species of lark were recorded overall including four species considered likely to breed within or in the vicinity of the development site. Two desert lark nests were located during the spring survey period near VP9. White-crowned wheatear is another commonly recorded species considered likely to breed within the development site. Common kestrel is the only target species that may breed within or in the immediate vicinity of the development site.

Further surveys were undertaken at Dawmat al Jandl Wetland IBA, the nearest designated area to the proposed development, in order to characterise the bird assemblage present there. A total of 124 species were recorded at the IBA across sixteen separate visits. Fifty-two of these species were also recorded at the development site.

The Ornithological Impact Assessment is detailed within the Dumat al Jandal Environmental and Social Impact Assessment (SA217900-04-G-REP-4003).

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8. Figures and Appendices

SA217900 DMT G PLN GE03	**Site Location**
SA217900 DMT G PLN GE06	**Site Layout**
SA217900 DMT G PLN TB06	**National Level Protected Areas (Designated and Proposed)**
SA217900 DMT G PLN TB09	**Migratory Bird Vantage Point Survey Locations**
SA217903 DMT G PLN TB12	**Terrestrial Ecology Survey Locations (Constant Effort Routes)**
SA217903 DMT G PLN TB18	**Spring Migration Flight Lines (TB18:1 – 16)**
SA217903 DMT G PLN TB19	**Autumn Migration Flight Lines (TB19:1 – 16)**
SA217900 DMT G PLN TB27	**Indicative Bird Migration Routes**

Appendix A. Full Species List

*All species recorded within the development site and at the Dawmat al Jandal Wetland IBA with IUCN (2017) conservation statuses and population trends. Grey indicates target species, * indicates species recorded within the development site and at the Dawmat al Jandal IBA. Species recorded only at the IBA are separated.*

Species	Scientific (Latin) Name	KSA Code	IUCN Conservation Status	IUCN Population Trend
Barn swallow*	*Hirundo rustica*	SWA	Least concern	Decreasing
Bar-tailed lark*	*Ammomanes cinctura*	BAL	Least concern	Decreasing
Bimaculated lark	*Melanocorypha bimaculata*	BIL	Least concern	Stable
Black kite*	*Milvus migrans*	BLK	Least concern	Unknown
Black redstart	*Phoenicurus ochruros*	BRS	Least concern	Increasing
Blackcap*	*Sylvia atricapilla*	BLC	Least concern	Increasing
Black-eared wheatear*	*Oenanthe hispanica*	BLW	Least concern	Decreasing
Blue-cheeked bee-eater*	*Merops persicus*	BCB	Least concern	Stable
Booted eagle*	*Hieraaetus pennatus*	BOE	Least concern	Unknown
Brown-necked raven	*Corvus ruficollis*	BRR	Least concern	Increasing
Common crane	*Grus grus*	CRA	Least concern	Increasing
Common hoopoe*	*Upupa epops*	HOO	Least concern	Decreasing
Common kestrel*	*Falco tinnunculus*	KES	Least concern	Decreasing
Common quail	*Coturnix coturnix*	QUA	Least concern	Decreasing
Common redstart*	*Phoenicurus phoenicurus*	RST	Least concern	Increasing
Common swift	*Apus apus*	SWI	Least concern	Stable
Common whitethroat*	*Sylvia communis*	COW	Least concern	Increasing
Cream-coloured courser	*Cursorius cursor*	CRC	Least concern	Decreasing
Crested lark*	*Galerida cristata*	CRL	Least concern	Decreasing
Desert finch*	*Rhodospiza obsoleta*	DEF	Least concern	Stable
Desert lark*	*Ammomanes deserti*	DEL	Least concern	Increasing
Desert wheatear*	*Oenanthe deserti*	DEW	Least concern	Stable
Eastern imperial eagle	*Aquila heliaca*	EIE	Vulnerable	Unknown
Egyptian vulture	*Neophron percnopterus*	EGV	Endangered	Decreasing
Eurasian collared dove*	*Streptopelia decaocto*	COD	Least concern	Increasing
Eurasian crag martin*	*Ptyonoprogne rupestris*	CRM	Least concern	Stable
Eurasian hobby	*Falco Subbuteo*	HOB	Least concern	Decreasing
Eurasian reed warbler*	*Acrocephalus scirpaceus*	REW	Least concern	Stable
Eurasian skylark	*Alauda arvensis*	SKY	Least concern	Decreasing
Eurasian sparrowhawk	*Accipiter nisus*	SPA	Least concern	Stable

Species	Scientific (Latin) Name	KSA Code	IUCN Conservation Status	IUCN Population Trend
Eurasian wryneck	*Jynx torquilla*	WRY	Least concern	Decreasing
European bee-eater*	*Merops apiaster*	BEE	Least concern	Stable
European honey buzzard*	*Pernis apivorus*	HNB	Least concern	Decreasing
European nightjar	*Caprimulgus europaeus*	NIJ	Least concern	Decreasing
European roller*	*Coracias garrulus*	ROL	Least concern	Decreasing
Finsch's wheatear	*Oenanthe finschii*	FIW	Least concern	Stable
Golden eagle	*Aquila chrysaetos*	GOE	Least concern	Stable
Greater hoopoe-lark*	*Alaemon alaudipes*	HOL	Least concern	Decreasing
Greater short-toed lark*	*Calandrella brachydactyla*	SHL	Least concern	Unknown
Griffon vulture	*Gyps fulvus*	GRV	Least concern	Increasing
Hen harrier	*Circus cyaneus*	HEH	Least concern	Decreasing
House sparrow*	*Passer domesticus*	HOS	Least concern	Decreasing
Isabelline wheatear*	*Oenanthe isabellina*	ISW	Least concern	Stable
Lesser kestrel	*Falco naumanni*	LEK	Least concern	Stable
Lesser spotted eagle	*Clanga pomarina*	LEE	Least concern	Stable
Levant sparrowhawk	*Accipiter brevipes*	LES	Least concern	Stable
Little bustard	*Tetrax Tetrax*	LBU	Near Threatened	Decreasing
Long-legged buzzard*	*Buteo rufinus*	LOB	Least concern	Stable
Marsh harrier*	*Circus aeruginosus*	MAH	Least concern	Increasing
Montagu's harrier*	*Circus pygargus*	MOH	Least concern	Decreasing
Namaqua dove*	*Oena capensis*	NAD	Least concern	Increasing
Northern house martin*	*Delichon urbicum*	HOM	Least concern	Decreasing
Northern wheatear*	*Oenanthe oenanthe*	NOW	Least concern	Decreasing
Osprey*	*Pandion haliaetus*	OSP	Least concern	Increasing
Pale crag martin*	*Ptyonoprogne obsoleta*	PCM	Least concern	Increasing
Pale rockfinch	*Carpospiza brachydactyla*	PRF	Least concern	Stable
Pallid harrier*	*Circus macrourus*	PAH	Least concern	Decreasing
Peregrine falcon	*Falco peregrinus*	PER	Least concern	Stable
Pharaoh eagle-owl	*Bubo ascalaphus*	PEO	Least concern	Stable
Pied wheatear*	*Oenanthe pleschanka*	PIW	Least concern	Stable
Purple heron*	*Ardea purpurea*	PUH	Least concern	Decreasing
Red-backed shrike*	*Lanius collurio*	RBS	Least concern	Decreasing
Red-rumped swallow*	*Cecropis daurica*	RRS	Least concern	Stable

Species	Scientific (Latin) Name	KSA Code	IUCN Conservation Status	IUCN Population Trend
Red-throated pipit*	*Anthus cervinus*	RTP	Least concern	Stable
Saker falcon	*Falco cherrug*	SAF	Endangered	Decreasing
Sand martin*	*Riparia riparia*	SAM	Least concern	Decreasing
Sandgrouse sp.	-	-	-	-
See-see partridge	*Ammoperdix griseogularis*	SSP	Least concern	Stable
Short-toed snake eagle	*Circaetus gallicus*	SHE	Least concern	Stable
Spanish sparrow	*Passer hispaniolensis*	SPS	Least concern	Decreasing
Steppe buzzard*	*Buteo buteo vulpinus*	SBZ	Least concern	Stable
Steppe eagle*	*Aquila nipalensis*	STE	Endangered	Decreasing
Tawny pipit*	*Anthus campestris*	TAP	Least concern	Stable
Temminck's lark	*Eremophila bilopha*	TEL	Least concern	Decreasing
Tree pipit*	*Anthus trivialis*	TRP	Least concern	Decreasing
Trumpeter finch*	*Buccaneers githagineus*	TRF	Least concern	Stable
Water pipit*	*Anthus spinoletta*	WAP	Least concern	Stable
Western yellow wagtail*	*Motacilla flava*	YEW	Least concern	Decreasing
Whinchat*	*Saxicola rubetra*	WHC	Least concern	Decreasing
White wagtail*	*Motacilla alba*	WWA	Least concern	Stable
White-crowned wheatear	*Oenanthe leucopyga*	WCW	Least concern	Stable
White-winged tern*	*Chlidonias leucopterus*	WWT	Least concern	Stable
Willow warbler*	*Phylloscopus trochilus*	WIW	Least concern	Decreasing
Woodchat shrike*	*Lanius senator*	WSH	Least concern	Decreasing
Species recorded only at the Dawmat al Jandal Wetland IBA				
African collared dove	*Streptopelia roseogrisea*	ACD	Least concern	Stable
Armenian gull	*Larus armenicus*	ARG	Near threatened	Decreasing
Black-crowned night heron	*Nycticorax nycticorax*	BNH	Least concern	Decreasing
Black-headed gull	*Chroicocephalus ridibundus*	BHG	Least concern	Unknown
Black-necked grebe	*Podiceps nigricollis*	BNG	Least concern	Unknown
Black-winged stilt	*Himantopus himantopus*	BWS	Least concern	Increasing
Broad-billed sandpiper	*Calidris falcinellus*	BSA	Least concern	Decreasing
Cattle egret	*Bubulcus ibis*	CAE	Least concern	Increasing
Citrine wagtail	*Motacilla citreola*	CIW	Least concern	Increasing
Common chiffchaff	*Phylloscopus collybita*	CHI	Least concern	Increasing
Common coot	*Fulica atra*	COO	Least concern	Increasing

Species	Scientific (Latin) Name	KSA Code	IUCN Conservation Status	IUCN Population Trend
Common moorhen	*Gallinula chloropus*	MOO	Least concern	Stable
Common redshank	*Tringa totanus*	RSH	Least concern	Unknown
Common ringed plover	*Charadrius hiaticula*	RPL	Least concern	Decreasing
Common sandpiper	*Actitis hypoleucos*	COS	Least concern	Decreasing
Common snipe	*Gallinago gallinago*	SNI	Least concern	Decreasing
Common tern	*Sterna hirundo*	COT	Least concern	Unknown
Curlew sandpiper	*Calidris ferruginea*	CUS	Near threatened	Decreasing
Dunlin	*Calidris alpina*	DUN	Least concern	Decreasing
Eastern olivaceous warbler	*Iduna pallida*	OLW	Least concern	Stable
Eurasian spoonbill	*Platalea leucorodia*	SPP	Least concern	Unknown
Eurasian teal	*Anas crecca*	TEA	Least concern	Unknown
European turtle dove	*Streptopelia turtur*	TUD	Vulnerable	Decreasing
Ferruginous duck	*Aythya nyroca*	FED	Near threatened	Decreasing
Garganey	*Spatula querquedula*	GAR	Least concern	Decreasing
Glossy ibis	*Plegadis falcinellus*	GLI	Least concern	Decreasing
Great cormorant	*Phalacrocorax carbo*	GRE	Least concern	Increasing
Great reed warbler	*Acrocephalus arundinaceus*	GRW	Least concern	Decreasing
Great white egret	*Ardea alba*	GWE	Least concern	Unknown
Greater sandplover	*Charadrius leschenaultii*	GSA	Least concern	Decreasing
Green sandpiper	*Tringa ochropus*	GSP	Least concern	Increasing
Greenshank	*Tringa nebularia*	GRS	Least concern	Stable
Grey heron	*Ardea cinerea*	GRH	Least concern	Unknown
Gull-billed tern	*Gelochelidon nilotica*	GUT	Least concern	Decreasing
Isabelline shrike	*Lanius isabellinus*	ISS	Least concern	Stable
Kentish plover	*Charadrius alexandrinus*	KEP	Least concern	Decreasing
Laughing dove	*Spilopelia senegalensis*	LAD	Least concern	Stable
Lesser whitethroat	*Sylvia curruca*	LEW	Least concern	Stable
Little bittern	*Ixobrychus minutus*	LIB	Least concern	Decreasing
Little egret	*Egretta garzetta*	LIE	Least concern	Increasing
Little grebe	*Tachybaptus ruficollis*	LGR	Least concern	Decreasing
Little ringed plover	*Charadrius dubius*	LIP	Least concern	Stable
Little stint	*Calidris minuta*	LST	Least concern	Increasing
Mallard	*Anas platyrhynchos*	MAL	Least concern	Increasing

Species	Scientific (Latin) Name	KSA Code	IUCN Conservation Status	IUCN Population Trend
Marsh sandpiper	*Tringa stagnatilis*	MRS	Least concern	Decreasing
Masked shrike	*Lanius nubicus*	MSH	Least concern	Decreasing
Northern pintail	*Anas acuta*	PIN	Least concern	Decreasing
Northern shoveler	*Spatula clypeata*	SHV	Least concern	Decreasing
Ortolan bunting	*Emberiza hortulana*	ORB	Least concern	Decreasing
Pallid swift	*Apus pallidus*	PSW	Least concern	Stable
Pied avocet	*Recurvirostra avosetta*	AVO	Least concern	Unknown
Red-necked phalarope	*Phalaropus lobatus*	RNP	Least concern	Decreasing
Ruff	*Calidris pugnax*	RUF	Least concern	Decreasing
Sanderling	*Calidris alba*	SAN	Least concern	Unknown
Siberian stonechat	*Saxicola maurus*	SIS	Unknown	Unknown
Slender-billed gull	*Chroicocephalus genei*	SLG	Least concern	Unknown
Southern grey shrike	*Lanius meridionalis*	SGS	Unknown	Unknown
Spotted crake	*Porzana porzana*	SPC	Least concern	Stable
Spotted flycatcher	*Muscicapa striata*	SPF	Least concern	Decreasing
Spotted redshank	*Tringa erythropus*	SPR	Least concern	Stable
Spur-winged lapwing	*Vanellus spinosus*	SPL	Least concern	Increasing
Squacco heron	*Ardeola ralloides*	SQH	Least concern	Unknown
Temminck's stint	*Calidris temminckii*	TES	Least concern	Unknown
Terek sandpiper	*Xenus cinereus*	TER	Least concern	Decreasing
Turkestan shrike	*Lanius phoenicuroides*	TUS	Least concern	Stable
Water rail	*Rallus aquaticus*	WAR	Least concern	Decreasing
White stork	*Ciconia ciconia*	WHW	Least concern	Increasing
White-cheeked bulbul	*Pycnonotus leucotis*	WCB	Least concern	Decreasing
White-tailed lapwing	*Vanellus leucurus*	WHL	Least concern	Unknown
Wood sandpiper	*Tringa glareola*	WSA	Least concern	Stable
Wood warbler	*Phylloscopus sibilatrix*	WOW	Least concern	Decreasing
Yellow-legged gull	*Larus michahellis*	YEG	Least concern	Increasing

Appendix B. KSA Bird Codes

Code	Species	Code	Species	Code	Species
ARB	Arabian babbler	BRR	Brown-necked raven	DUN	Dunlin
ARG	Armenian gull	CAL	Calandra lark	EBW	Eastern Bonelli's warbler
ADW	Asian desert warbler	CAG	Caspian gull	OLW	Eastern olivaceous warbler
AVO	Avocet	CAT	Caspian tern	ORW	Eastern Orphean warbler
BAC	Baillon's crake	CAE	Cattle egret	EGG	Egyptian goose
BAF	Barbary falcon	CEW	Cetti's warbler	EGN	Egyptian nightjar
BAO	Barn owl	CHA	Chaffinch	EGV	Egyptian vulture
BAW	Barred warbler	CHI	Chiffchaff	FAR	Fan-tailed raven
BAG	Bar-tailed godwit	CHU	Chukar	FED	Ferruginous duck
BAL	Bar-tailed lark	CIW	Citrine wagtail	FIW	Finsch's wheatear
BEE	Bee-eater	CRW	Clamorous reed warbler	GAD	Gadwall
BIL	Bimaculated lark	COD	Collared dove	GAW	Garden warbler
BLF	Black francolin	COF	Collared flycatcher	GAR	Garganey
BLK	Black kite	COM	Common myna	GLI	Glossy ibis
BRS	Black redstart	CRO	Common rosefinch	GOO	Golden oriole
BST	Black stork	COS	Common sandpiper	GOP	Golden plover
BBS	Black-bellied sandgrouse	COT	Common tern	GPR	Graceful prinia
BLB	Blackbird	COW	Common whitethroat	GRB	Great bittern
BBR	Black-bush robin	COO	Coot	GRC	Great cormorant
BLC	Blackcap	COB	Corn bunting	GRW	Great reed warbler
BNH	Black-crowned night heron	COC	Corncrake	GWE	Great white egret
BSL	Black-crowned sparrow lark	CRM	Crag martin	GWP	Great white pelican
BLW	Black-eared wheatear	CRA	Crane	GRF	Greater flamingo
BHG	Black-headed gull	CRC	Cream-coloured courser	GSA	Greater sandplover
BNG	Black-necked grebe	CRL	Crested lark	GSE	Greater-spotted eagle
BTG	Black-tailed godwit	CRB	Cretzschmar's bunting	GSC	Great-spotted cuckoo
BWK	Black-winged kite	CUC	Cuckoo	GSP	Green sandpiper
BLP	Black-winged pratincole	CUR	Curlew	GNF	Greenfinch
BWS	Black-winged stilt	CUS	Curlew sandpiper	GRS	Greenshank
BCB	Blue-cheeked bee-eater	DSS	Dead Sea sparrow	GRH	Grey heron
BLU	Bluethroat	DEF	Desert finch	GPL	Grey plover
BLE	Bonelli's eagle	DEL	Desert lark	GYW	Grey wagtail
BOE	Booted eagle	DTO	Desert tawny owl	GRG	Greylag goose
BSA	Broad-billed sandpiper	DEW	Desert wheatear	GRV	Griffon vulture

Code	Species	Code	Species	Code	Species
GUT	Gull-billed tern	LIE	Little egret	PAH	Pallid harrier
HAW	Hawfinch	LGR	Little grebe	PSW	Pallid swift
HEH	Hen harrier	LGB	Little green bee-eater	PET	Penduline tit
HEG	Heuglin's gull	LGU	Little gull	PER	Peregrine
HOB	Hobby	LIO	Little owl	PEO	Pharaoh eagle owl
HNB	Honey buzzard	LST	Little stint	PIK	Pied kingfisher
HOC	Hooded crow	LSW	Little swift	PIW	Pied wheatear
HOW	Hooded wheatear	LIT	Little tern	PIN	Pintail
HOO	Hoopoe	LIP	Little-ringed plover	PIS	Pin-tailed sandgrouse
HOL	Hoopoe lark	LOO	Long-eared owl	POC	Pochard
HUC	House crow	LOB	Long-legged buzzard	PUH	Purple heron
HOM	House martin	LOS	Long-tailed skua	PUS	Purple swamphen
HOS	House sparrow	MAL	Mallard	PYC	Pygmy cormorant
IME	Imperial eagle	MAH	Marsh harrier	QUA	Quail
INS	Indian silverbill	MRS	Marsh sandpiper	RAV	Raven
ISS	Isabelline shrike	MAW	Marsh warbler	RBS	Red-backed shrike
ISW	Isabelline wheatear	MSH	Masked shrike	REF	Red-breasted flycatcher
JAC	Jackdaw	MEP	Meadow pipit	REG	Red-necked grebe
JAY	Jay	MOH	Montagu's harrier	RNP	Red-necked phalarope
KEP	Kentish plover	MOO	Moorhen	RRS	Red-rumped swallow
KES	Kestrel	MWE	Mourning wheatear	RSH	Redshank
KIN	Kingfisher	MOW	Moustached warbler	RST	Redstart
LAP	Lapwing	NAD	Namaqua dove	RTP	Red-throated pipit
LAD	Laughing dove	NIG	Nightingale	RWI	Redwing
LEF	Lesser flamingo	NIJ	Nightjar	REB	Reed bunting
LGS	Lesser grey shrike	NOW	Northern wheatear	REW	Reed warbler
LEK	Lesser kestrel	NUN	Nubian nightjar	RPL	Ringed plover
LSL	Lesser short-toed lark	OTW	Olive-tree warbler	RIP	Ring-necked parakeet
LEW	Lesser whitethroat	OHB	Oriental honey buzzard	ROB	Robin
LBG	Lesser-black backed gull	ORS	Oriental skylark	ROD	Rock dove
LBU	Little bustard	OTD	Oriental turtle dove	ROL	Roller
LEE	Lesser-spotted eagle	ORB	Ortolan bunting	ROS	Rose-coloured starling
LES	Levant sparrowhawk	OSP	Osprey	RUF	Ruff
LIN	Linnet	PCM	Pale crag martin	RUR	Rufous-bush robin
LIB	Little bittern	PRF	Pale rockfinch	RUW	Ruppell's warbler
LIC	Little crake	PAG	Pallas's gull	SAF	Saker falcon

Code	Species	Code	Species	Code	Species
SAM	Sand martin	SPR	Spotted redshank	TUR	Turnstone
SAP	Sand partridge	SSA	Spotted sandgrouse	TUD	Turtle dove
SAN	Sanderling	SPL	Spur-winged lapwing	TUS	Turkestan shrike
SAT	Sandwich tern	SQH	Squacco heron	WAP	Water pipit
SDW	Sardinian warbler	STA	Starling	WAR	Water rail
SVW	Savi's warbler	SBZ	Steppe buzzard	WRE	Western reef egret
SCO	Scops owl	STE	Steppe eagle	WHB	Whimbrel
SEW	Sedge warbler	STG	Steppe gull	WHC	Whinchat
SSP	See-see partridge	STD	Stock dove	WST	Whiskered tern
SEO	Short-eared owl	STC	Stone curlew	WHS	White stork
SHE	Short-toed eagle	STO	Stonechat	WWA	White wagtail
SHL	Short-toed lark	SSW	Streaked scrub warbler	WCB	White-cheeked bulbul
SHV	Shoveler	STH	Striated heron	WCW	White-crowned wheatear
SIS	Siberian stonechat	SUW	Subalpine warbler	WHG	White-eyed gull
SKY	Skylark	SWA	Swallow	WSB	White-spectacled bulbul
SLG	Slender-billed gull	SWI	Swift	WHL	White-tailed lapwing
SNI	Snipe	TAP	Tawny pipit	WHK	White-throated kingfisher
SOT	Song thrush	TEA	Teal	WWT	White-winged tern
SOF	Sooty falcon	TEL	Temminck's lark	WIG	Wigeon
SGS	Southern grey shrike	TER	Terek sandpiper	WIW	Willow warbler
SPS	Spanish sparrow	TES	Temminck's stint	WSA	Wood sandpiper
SPA	Sparrowhawk	THN	Thrush nightingale	WOW	Wood warbler
SPW	Spectacled warbler	TRP	Tree pipit	WSH	Woodchat shrike
SPO	Spoonbill	TRS	Tristram's starling	WRY	Wryneck
SPC	Spotted crake	TRF	Trumpeter finch	YEW	Yellow wagtail
SPF	Spotted flycatcher	TFD	Tufted duck	YEG	Yellow-legged gull

Appendix C. Survey Dates, Times, Observers and Weather

Observers: CC – Calum Campbell; EF – Euan Ferguson; PC – Paul Cook; PH – Paul Hill.

Wind speed: Beaufort scale 0 (no wind), to 12 (hurricane); Wind Direction (16-point compass); Temperature (ºC);
Cloud Cover: Okta scale 0 (no cloud), to 8 (total cloud cover): Cloud Height; 0 (0m), 1 (0-500m), 2 (500m+) R (Rain);
Visibility: 0 (poor <1km), 1 (1-2km), 2 (>2km), D (Dust), F (Fog), HH (Heat Haze), SS (Sandstorm).

Vantage Point Survey Details (VP locations are shown in Figure TB09

Date	VP	Start Time	End Time	Observer(s)	Wind Speed	Wind Direction	Temp. (ºC)	Cloud (C:H)	Visibility
Spring Survey Period									
12/03/2017	4	07:45	10:45	CC	2-4	SE	8-16	0	2
12/03/2017	5	11:15	14:15	CC	3-4	SE	17-21	0	2
13/03/2017	6	07:00	10:00	CC	4	N-NW	8-15	0	2
13/03/2017	7	10:30	13:30	CC	4-5	N-NW	17-20	0	2
14/03/2017	8	06:45	09:45	CC	2	NE	10-16	0	2
14/03/2017	9	10:15	13:15	CC	1	NW	18-23	0	2
15/03/2017	1	07:30	10:30	CC	1	N-E	10-17	0	2
15/03/2017	2	11:00	14:00	CC	2-3	SE	18-22	0	2
16/03/2017	3	07:15	10:15	CC	3-5	W	10-16	0	2
16/03/2017	4	10:45	13:45	CC	4-5	W	18-21	0	2
19/03/2017	2	07:15	10:15	CC	2-5	NW	10-17	4-7/8:2	2
19/03/2017	1	10:45	13:45	CC	4-6	NW	18-21	7-8/2	(2) D
20/03/2017	5	06:45	09:45	CC	5	NNW	8-15	0-2/8:2	(2) D
20/03/2017	3	10:15	13:15	CC	4-5	NW	18-21	0	2
21/03/2017	6	06:45	09:45	CC	1-3	NW	8-14	0	2
21/03/2017	7	10:15	13:15	CC	3	NW	16-18	0-8/8:2	2
22/03/2017	9	06:30	09:30	CC	1-2	N	7-14	8/8:2	2
22/03/2017	8	10:00	13:00	CC	2-3	NW-NE-E	15-18	7-8/8:2	2
23/03/2017	5	07:00	10:00	CC	0-1	N	9-14	6-8/8:2	2
23/03/2017	1	10:30	13:30	CC	3-5	NW-N-NW	16-18	8/8:2	2
25/03/2017	4	07:00	10:00	CC & PH	1	N	9-15	0	2
25/03/2017	2	10:30	13:30	CC	1-3	N	16-21	0-1/8:2	2
25/03/2017	3	10:30	13:30	PH	1-3	N	16-21	0-1/8:2	2
26/03/2017	7	07:00	10:00	PH	1-2	SE-N-SE	9-19	0	2
26/03/2017	6	10:30	13:30	PH	2-4	SE	19-23	0	2
27/03/2017	9	06:30	09:30	PH	4	S	9-20	0-1/8:2	2
27/03/2017	8	10:00	13:00	PH	4-5	S	20-22	2/8:2	1-2 HH
28/03/2017	5	11:30	14:30	PH	4-6	N-W	19-20	0-1/8:2	2
28/03/2017	1	15:00	18:00	PH	4	W	20-24	1-3/8:2	2
29/03/2017	4	08:45	11:45	PH	1	NW	16-24	0-1/8:2	2
29/03/2017	3	12:15	15:15	PH	1-2	NW	24-26	0-3/8:2	2
30/03/2017	6	08:45	11:45	PH	1-2	SE	20-27	6-7/8:2	2

Date	VP	Start Time	End Time	Observer(s)	Wind Speed	Wind Direction	Temp. (°C)	Cloud (C:H)	Visibility
30/03/2017	3	12:15	15:15	PH	2-3	SE	27	3-6/8:2	2
02/04/2017	8	07:00	10:00	PH	0-1	NW	13-20	2-3/8:2	2
02/04/2017	9	10:30	13:30	PH	1	NW	20-24	0	2
03/04/2017	7	08:50	11:50	PH	5-6	W-WSW	13-16	0	2
03/04/2017	6	12:15	15:15	PH	2-4	WSW-W	22-24	0	2
04/04/2017	4	10:45	13:45	PH	0-1	N-S-N	23-25	0	2
04/04/2017	5	14:15	17:15	PH	1	ENE	25-27	0	2
05/04/2017	8	10:00	13:00	PH	3-4	ESE	3-4	1-4/8:2	1-2 D
05/04/2017	2	13:30	16:30	PH	5-6	ESE	24	7-8/8:2	1-2 D
06/04/2017	3	09:30	12:30	PH	2-3	S	24-29	0	2
06/04/2017	1	13:00	16:00	PH	2-4	W-NW	29-31	0	1-2 D
09/04/2017	9	07:00	10:00	PH	0-1	NNE	16-26	0	2
09/04/2017	8	10:30	13:30	PH	0-1	NNE-ENE	26-30	0	2
10/04/2017	6	09:00	12:00	PH	0-1	ENE	20-26	0	2
10/04/2017	7	12:30	15:30	PH	0-1	ENE	26-30	0	1-2 D
11/04/2017	4	10:15	13:15	PH	3-5	NE	23-28	0-5/8:2	(2) D
11/04/2017	5	13:45	16:45	PH	2	NE	29-31	8/8:2	1-2 D
12/04/2017	3	09:45	12:45	PH	3-4	SSE-SW	20-22	8/8:2	1-2 D
12/04/2017	1	13:45	16:45	PH	1-6	SW	24-26	8/8:0-2	0-2 SS
13/04/2017	2	09:20	12:20	PH	2-4	NE-N	22-26	8/8:2	2
13/04/2017	4	12:45	15:45	PH	3-4	NE-E-N	25-26	8/8:2 (R)	0-2 D
16/04/2017	1	09:20	12:20	PH	0-1	ENE	19-23	0	2
16/04/2017	4	12:40	15:40	PH	0-1	ENE	23-26	0	2
17/04/2017	6	08:55	11:55	PH	2-4	SW	19-22	3-6/8:2	2
17/04/2017	7	12:15	15:15	PH	4	SW-W	26	4-8/8:2	2
18/04/2017	5	08:15	11:15	PH/EF	0-2	W-NW-N	18-23	0	2
18/04/2017	2	12:15	15:15	PH	4-6	N-NW-WNW	26	0-1/8:2	2
18/04/2017	3	12:15	15:15	EF	4-6	N-NW-WNW	26	0-1/8:2	2
19/04/2017	8	08:45	11:45	EF	0-1	SE	21-25	0	2
19/04/2017	9	08:45	11:45	PH	0-1	SE	21-25	0	2
20/04/2017	4	06:30	09:30	EF	0-1	SSW-S	16-20	0	2
20/04/2017	1	10:00	13:00	EF	2-3	SE-S	24-29	0	2
23/04/2017	5	08:15	11:15	EF	2-3	ENE-E	23-24	7-8/8:2 (R)	2
23/04/2017	6	11:45	14:45	EF	3-4	E-ESE	26-28	5-6/8:2	2
24/04/2017	7	08:00	11:00	EF	3-5	NW-NNW	15-19	8/8:2	1-2 F
24/04/2017	8	11:30	14:30	EF	2-3	N	22-27	8/8:2	1-2 F
24/04/2017	9	15:00	18:00	EF	1-2	NW-E-ESE	22-27	8/8:2	1-2 F
25/04/2017	1	09:00	12:00	EF	2-3	E-SE	19-22	8/8:2	1-2 F
25/04/2017	2	12:30	15:30	EF	1-3	ESE-E	24-25	8/8:2	1-2 F
26/04/2017	5	11:30	14:30	EF	3-4	E	27-28	0	2

Date	VP	Start Time	End Time	Observer(s)	Wind Speed	Wind Direction	Temp. (°C)	Cloud (C:H)	Visibility
26/04/2017	3	15:00	18:00	EF	3-4	E-ENE-E	25-28	0-1/8:2	2
27/04/2017	7	08:30	11:30	EF	5	SE-SSE	23-26	0-2/8:2	2
27/04/2017	9	12:00	15:00	EF	5-6	SE-ESE-E	5-6	4-7/8:2	2
30/04/2017	8	11:30	14:30	EF	2-4	W	31-32	7-8/8:1-2	0-2 SS
30/04/2017	7	15:00	18:00	EF	1-3	NW-W	27-30	6-8/8:2	0-2 SS
01/05/2017	2	07:00	10:00	EF	2-3	SSW-S-SW	25-28	2-4/8:2	2
01/05/2017	3	10:30	13:30	EF	3	SW-WSW	28-29	5-7/8:2	2
02/05/2017	6	09:00	12:00	EF	1-2	NW-N	25-28	0	2
02/05/2017	9	12:30	15:30	EF	2-3	NW-W	30-31	1-2/8:2	2
Autumn Survey Period									
06/09/2017	1	09:30	12:30	CC	1-3	S - SE	38-39	1-4/8:2	2
06/09/2017	2	13:00	16:00	CC	2-3	S - SE	40	2-5/8:2	2
07/09/2017	3	09:30	12:30	CC	3-4	NW	30-35	0	2
07/09/2017	4	13:00	16:00	CC	2	NW	36	0	2
10/09/2017	5	08:45	11:45	CC	1-2	SE	31-36	0	2
10/09/2017	6	12:15	15:15	CC	1-2	SE	37	0	2
11/09/2017	7	08:30	11:30	CC	1-2	SE	32-37	0	2
11/09/2017	8	12:00	15:00	CC	1-3	E	40	0	2
12/09/2017	9	08:30	11:30	CC	1-2	E	32-38	0	2
12/09/2017	1	12:00	15:00	CC	1-2	E	40	0	2
13/09/2017	2	08:45	11:45	CC	1-2	E	31-37	0	2
13/09/2017	3	12:15	15:15	CC	1-2	SE	40-41	0	2
14/09/2017	4	09:00	12:00	CC	2-3	NE	33-38	0	2
14/09/2017	5	12:30	15:30	CC	1-2	NE	40	0	2
17/09/2017	6	08:30	11:30	CC	1-2	NE	30-35	0	2
17/09/2017	7	12:00	15:00	CC	1-2	NE - E -SE	36-37	0	2
18/09/2017	9	08:00	11:00	CC	1-2	N-NE	27-36	0	2
18/09/2017	8	11:30	14:30	CC	1-2	SE	37	0	2
19/09/2017	1	08:45	11:45	CC	0-2	S	31-39	0	2
19/09/2017	2	12:15	15:15	CC	2-5	SW	40-41	0	2
20/09/2017	3	08:45	11:45	CC	2	N	28-36	0	2
20/09/2017	4	12:15	15:15	CC	2	NE	36	0	2
21/09/2017	5	08:30	11:30	CC	3-4	N - NNW	27-31	2-3/8:2	2
21/09/2017	6	12:00	15:00	CC	2-3	NW	36	2-4/8:2	2
24/09/2017	7	08:30	11:30	CC	2-4	E-SE	30-33	3-5/8:2	2
24/09/2017	9	12:00	15:00	CC	3-6	SE	34-35	5-8/8:2	2
25/09/2017	8	08:30	11:30	CC	2-4	SE	31-34	0-1/8:2	2
25/09/2017	2	12:00	15:00	CC	2-3	SSE - SE - S	36	0	2
26/09/2017	7	11:45	14:45	CC	3-5	S - W	37	0	2
26/09/2017	1	15:15	18:15	CC	2-3	W	29-37	0	2

Date	VP	Start Time	End Time	Observer(s)	Wind Speed	Wind Direction	Temp. (°C)	Cloud (C:H)	Visibility
27/09/2017	3	08:45	11:45	CC	2	E - SE - S	27-31	0	2
27/09/2017	4	12:15	15:15	CC	1-2	SE	33-34	0	2
28/09/2017	5	08:30	11:30	PC	3	NE - E	24-27	2-5/8:2	2
28/09/2017	6	08:30	11:30	CC	3	NE - E	24-27	2-5/8:2	2
28/09/2017	8	12:00	15:00	CC	1-3	E	33-34	0	2
28/09/2017	9	12:00	15:00	PC	1-3	E	33-34	0	2
01/10/2017	1	08:00	11:00	CC & PC	0-2	NE - N	23-30	0	2
01/10/2017	2	11:30	14:30	PC	0-1	N - S	31-33	0	2
01/10/2017	3	11:30	14:30	CC	0-1	N - S	31-33	0	2
02/10/2017	4	07:15	10:15	PC	3-4	N	19-24	0	2
02/10/2017	5	10:45	13:45	PC	1-4	N - NE	26-33	0	2
03/10/2017	6	08:00	11:00	PC	3-4	E - ESE	22-26	0	2
03/10/2017	7	11:30	14:30	PC	4	ESE - E	31-33	0	2
04/10/2017	8	08:00	11:00	PC	2-3	N - NE-E	21-24	0	2
04/10/2017	9	11:30	14:30	PC	1-3	E - ESE - S	27-32	0	2
05/10/2017	1	07:30	10:30	PC	3-6	E	19-23	0	2
05/10/2017	2	11:00	14:00	PC	6-7	E	26-28	0	2
08/10/2017	3	08:00	11:00	PC	1-3	S	20-25	0	2
08/10/2017	4	11:30	14:30	PC	3-6	S	27-28	0	2
09/10/2017	1	07:15	10:15	PC	3-5	WNW - NW - W	18-22	0	2
09/10/2017	5	10:45	13:45	PC	4-5	W - SW	26-29	0	2
10/10/2017	6	07:45	10:45	PC	3-4	N	19-21	0	2
10/10/2017	7	11:15	14:15	PC	1-3	N - NNE - E	26-31	0	2
10/10/2017	8	14:45	17:45	PC	1	E - SE	29-31	0	2
11/10/2017	9	06:30	09:30	PC	2	N	16-21	0	2
11/10/2017	2	10:00	13:00	PC	1-2	N	24-29	0	2
11/10/2017	3	13:30	16:30	PC	1-2	N	31-33	0	2
16/10/2017	4	06:45	09:45	PC	3-5	NE - E - NE	15-18	0	2
16/10/2017	5	10:15	13:15	PC	3-5	ENE - E - NE	22-28	0	2
16/10/2017	6	13:45	16:45	PC	4-6	SE - S	30-31	0	2
17/10/2017	7	06:45	09:45	PC	1-3	N - NE	15-21	0	2
17/10/2017	8	10:15	13:15	PC	6-7	ENE - NE	24-25	0	1-2 D
18/10/2017	1	07:00	10:00	PC	1-3	N - NE	15-20	0	2
18/10/2017	2	10:30	13:30	PC	4	NE	23-25	0	2
18/10/2017	9	14:00	17:00	PC	5-6	ENE - E	26-27	0	2
19/10/2017	3	07:00	10:00	PC	3-4	E	15-18	0	2
19/10/2017	4	10:30	13:30	PC	5-6	E - SE	20-26	0	2
22/10/2017	5	07:00	10:00	PC	1	E - ESE - S	15-18	0	2
22/10/2017	6	10:30	13:30	PC	0	S - SW - WSW	21-27	0	2
23/10/2017	7	06:45	09:45	PC	1	E - NE	14-19	0	2

Date	VP	Start Time	End Time	Observer(s)	Wind Speed	Wind Direction	Temp. (°C)	Cloud (C:H)	Visibility
23/10/2017	8	10:15	13:15	PC	2-4	ENE - E	23-28	0	2
24/10/2017	9	07:00	10:00	PC	2-3	SE-ESE-E	21-24	0	2

JACOBS ZATE

Appendix D. Vantage Point Survey Data

Observers: CC – Calum Campbell; EF – Euan Ferguson; PC – Paul Cook; PH – Paul Hill. S: Spring Height Bands. A: Autumn Height Bands.

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
Spring Survey Period																			
12/03/2017	07:50	CC	4	STE	STE1	1		1			137		137			0	100	0	0
13/03/2017	08:22	CC	7	KES	KES1	1		1			88		88			0	100	0	0
14/03/2017	10:36	CC	9	SBZ	SBZ1	1			1		330			232	98	0	0	70	30
15/03/2017	10:04	CC	1	MAH	MAH1	1			1		275			275		0	0	100	0
16/03/2017	08:02	CC	3	PAH	PAH1	1	1				94	94				100	0	0	0
16/03/2017	09:25	CC	3	SBZ	SBZ2	1		1			112		112			0	100	0	0
19/03/2017	07:32	CC	2	KES	KES2	1	1				127	83	44			65	35	0	0
19/03/2017	07:54	CC	2	BLK	BLK1	1	1				68	68				100	0	0	0
19/03/2017	08:38	CC	2	MAH	MAH2	1	1				110	110				100	0	0	0
19/03/2017	09:36	CC	2	PAH	PAH2	1	1				55	55				100	0	0	0
19/03/2017	09:37	CC	2	SBZ	SBZ3	1		1			188		68	120		0	36	64	0
19/03/2017	09:57	CC	2	KES	KES3	1	1				95	95				100	0	0	0
19/03/2017	10:57	CC	1	SBZ	SBZ4	1		1			34		34			0	100	0	0
20/03/2017	09:17	CC	5	MAH	MAH3	1	1				75	75				100	0	0	0
20/03/2017	09:40	CC	5	STE	STE2	1			1		194			194		0	0	100	0
20/03/2017	11:12	CC	3	KES	KES4	1	1				84	84				100	0	0	0
20/03/2017	11:40	CC	3	SBZ	SBZ5	1		1			76		76			0	100	0	0
21/03/2017	06:53	CC	6	MAH	MAH4	1	1				64	64				100	0	0	0
21/03/2017	07:57	CC	6	MAH	MAH5	1	1				47	47				100	0	0	0
21/03/2017	08:19	CC	6	PAH	PAH3	1	1				80	80				100	0	0	0
21/03/2017	08:30	CC	6	PAH	PAH4	1	1				68	68				100	0	0	0
22/03/2017	06:50	CC	9	KES	KES5	1	1				55	55				100	0	0	0
22/03/2017	08:02	CC	9	KES	KES6	1	1				90	90				100	0	0	0
22/03/2017	10:01	CC	8	MAH	MAH6	1	1				50	50				100	0	0	0
22/03/2017	10:20	CC	8	LOB	LOB1	1			1		105			105		0	0	100	0
22/03/2017	10:26	CC	8	MAH	MAH7	2			1		174			174		0	0	100	0
23/03/2017	09:37	CC	5	MAH	MAH8	1		1			50		50			0	100	0	0
23/03/2017	09:38	CC	5	MAH	MAH9	2		1			118		118			0	100	0	0
23/03/2017	09:40	CC	5	MAH	MAH10	1	1				92	92				100	0	0	0
23/03/2017	09:55	CC	5	KES	KES7	1		1			105		105			0	100	0	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
23/03/2017	09:57	CC	5	STE	STE3	1		1			250		250			0	100	0	0
23/03/2017	13:25	CC	1	SHE	SHE1	1		1			175		175			0	100	0	0
25/03/2017	07:24	CC & PH	4	MAH	MAH11	1	1				50	50				100	0	0	0
25/03/2017	07:45	CC & PH	4	MAH	MAH12	1	1				166	166				100	0	0	0
25/03/2017	07:50	CC & PH	4	PAH	PAH5	1	1				20	20				100	0	0	0
25/03/2017	07:56	CC & PH	4	MAH	MAH13	1	1				115	115				100	0	0	0
25/03/2017	08:10	CC & PH	4	PAH	PAH6	1	1				70	70				100	0	0	0
25/03/2017	08:14	CC & PH	4	MAH	MAH14	1	1				160	100	60			63	38	0	0
25/03/2017	08:15	CC & PH	4	MAH	MAH15	1	1				90	90				100	0	0	0
25/03/2017	08:40	CC & PH	4	MAH	MAH16	2	1				185	185				100	0	0	0
25/03/2017	08:41	CC & PH	4	MAH	MAH17	1		1			156		156			0	100	0	0
25/03/2017	08:42	CC & PH	4	MAH	MAH18	1	1				75	75				100	0	0	0
25/03/2017	08:43	CC & PH	4	MAH	MAH19	1		1			120		120			0	100	0	0
25/03/2017	08:45	CC & PH	4	MAH	MAH20	5		1			290		290			0	100	0	0
25/03/2017	08:49	CC & PH	4	MAH	MAH21	3	1				300	300				100	0	0	0
25/03/2017	08:51	CC & PH	4	MAH	MAH22	1	1				57	57				100	0	0	0
25/03/2017	08:56	CC & PH	4	MAH	MAH23	1	1				223	74	73	76		33	33	34	0
25/03/2017	09:05	CC & PH	4	MAH	MAH24	2		1			130		60	70		0	46	54	0
25/03/2017	09:17	CC & PH	4	KES	KES8	2	1				157	157				100	0	0	0
25/03/2017	09:34	CC & PH	4	SBZ	SBZ6	1			1		180			104	76	0	0	58	42
25/03/2017	09:45	CC & PH	4	STE	STE4	2			1		270			270		0	0	100	0
25/03/2017	09:55	CC & PH	4	STE	STE5	1			1		40			40		0	0	100	0
25/03/2017	10:22	PH	3	PAH	PAH7	1	1				50	50				100	0	0	0
25/03/2017	11:10	PH	3	STE	STE6	2				1	120				120	0	0	0	100
25/03/2017	11:35	PH	3	STE	STE7	1			1		90			90		0	0	100	0
26/03/2017	10:54	PH	6	SBZ	SBZ7	1		1			180		30	70	80	0	17	39	44
26/03/2017	11:00	PH	6	SBZ	SBZ8	8			1		270			30	240	0	0	11	89
26/03/2017	11:20	PH	6	SBZ	SBZ9	9			1		90			30	60	0	0	33	67
27/03/2017	10:00	PH	8	MAH	MAH25	1	1				90	90				100	0	0	0
27/03/2017	10:30	PH	8	MAH	MAH26	1	1				130	130				100	0	0	0
27/03/2017	10:35	PH	8	PAH	PAH8	1	1				60	60				100	0	0	0
27/03/2017	11:00	PH	8	KES	KES9	1		1			45		45			0	100	0	0
28/03/2017	14:00	PH	1	PAH	PAH9	1	1				45	45				100	0	0	0

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Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
29/03/2017	14:15	PH	3	SBZ	SBZ10	1			1		240			60	180	0	0	25	75
30/03/2017	09:05	PH	6	LOB	LOB2	1		1			60		60			0	100	0	0
30/03/2017	09:10	PH	6	SHE	SHE2	1		1			50		50			0	100	0	0
30/03/2017	09:15	PH	6	PAH	PAH10	1	1				20	20				100	0	0	0
30/03/2017	09:30	PH	6	SBZ	SBZ11	1		1			101		64	37		0	63	37	0
30/03/2017	09:38	PH	6	PAH	PAH11	1	1				60	60				100	0	0	0
30/03/2017	09:49	PH	6	PAH	PAH12	1	1				60	60				100	0	0	0
30/03/2017	10:00	PH	6	PAH	PAH13	1	1				40	40				100	0	0	0
30/03/2017	10:16	PH	6	SBZ	SBZ12	2		1			40		40			0	100	0	0
30/03/2017	10:17	PH	6	BLK	BLK2	1	1				60	60				100	0	0	0
30/03/2017	10:19	PH	6	BLK	BLK3	4		1			40		40			0	100	0	0
30/03/2017	10:26	PH	6	LOB	LOB3	1		1			60		60			0	100	0	0
30/03/2017	10:30	PH	6	SBZ	SBZ13	1			1		15			15		0	0	100	0
30/03/2017	10:30	PH	6	SBZ	SBZ14	1			1		20			20		0	0	100	0
30/03/2017	11:00	PH	6	BLK	BLK4	1			1		15			15		0	0	100	0
30/03/2017	11:05	PH	6	SHE	SHE3	1			1		60			60		0	0	100	0
02/04/2017	09:43	PH	8	PAH	PAH14	1	1				190	10	30	90	60	5	16	47	32
03/04/2017	09:30	PH	7	MAH	MAH27	1	1				20	20				100	0	0	0
05/04/2017	10:40	PH	8	MAH	MAH28	1		1			150		30	120		0	20	80	0
05/04/2017	10:50	PH	8	HEH	HEH1	1	1				145	30	60	55		21	41	38	0
05/04/2017	11:40	PH	8	SBZ	SBZ15	3			1		90			30	60	0	0	33	67
05/04/2017	13:44	PH	2	KES	KES10	1		1			15		15			0	100	0	0
05/04/2017	15:20	PH	2	MAH	MAH29	1		1			20		20			0	100	0	0
05/04/2017	15:40	PH	2	PAH	PAH15	1	1				35	35				100	0	0	0
05/04/2017	15:50	PH	2	MAH	MAH30	1		1			30		30			0	100	0	0
06/04/2017	11:35	PH	3	PAH	PAH16	1	1				40	40				100	0	0	0
09/04/2017	08:00	PH	9	BLK	BLK5	1	1				120	120				100	0	0	0
11/04/2017	10:40	PH	4	MAH	MAH31	1	1				130	10	30	60	30	8	23	46	23
11/04/2017	15:00	PH	5	LEK	LEK1	2	1				90	90				100	0	0	0
11/04/2017	15:40	PH	5	SBZ	SBZ16	1		1			120		30	90		0	25	75	0
11/04/2017	15:47	PH	5	PAH	PAH17	1	1				60	60				100	0	0	0
11/04/2017	15:55	PH	5	MOH	MOH1	2	1				60	60				100	0	0	0
11/04/2017	16:37	PH	5	MOH	MOH2	1	1				90	30	30	30		33	33	33	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
12/04/2017	11:10	PH	3	MOH	MOH3	1	1				30	30				100	0	0	0
12/04/2017	11:15	PH	3	SPA	SPA1	1			1		60			60		0	0	100	0
12/04/2017	13:30	PH	1	MOH	MOH4	1	1				20	20				100	0	0	0
13/04/2017	11:30	PH	2	KES	KES11	1	1				30	30				100	0	0	0
13/04/2017	11:40	PH	2	KES	KES12	1	1				40	40				100	0	0	0
13/04/2017	14:24	PH	4	MOH	MOH5	2	1				300	300				100	0	0	0
16/04/2017	13:52	PH	4	MOH	MOH6	1	1				120	120				100	0	0	0
17/04/2017	09:40	PH	6	MOH	MOH7	1	1				40	40				100	0	0	0
17/04/2017	09:41	PH	6	BLK	BLK6	5	1				130	30	40	60		23	31	46	0
17/04/2017	10:16	PH	6	SHE	SHE4	1			1		330			330		0	0	100	0
17/04/2017	11:26	PH	6	STE	STE8	1			1		30			30		0	0	100	0
18/04/2017	09:05	PH & EF	5	HEH	HEH2	2	1				150	150				100	0	0	0
18/04/2017	09:06	PH & EF	5	MOH	MOH8	1	1				90	30	60			33	67	0	0
18/04/2017	09:10	PH & EF	5	MOH	MOH9	1	1				90	90				100	0	0	0
18/04/2017	09:10	PH & EF	5	MOH	MOH10	2	1				120	120				100	0	0	0
18/04/2017	09:15	PH & EF	5	MOH	MOH11	2	1				210	30	60	60	60	14	29	29	29
18/04/2017	09:18	PH & EF	5	MOH	MOH12	1	1				120	120				100	0	0	0
18/04/2017	10:05	PH & EF	5	PAH	PAH18	1	1				45	15	30			33	67	0	0
18/04/2017	10:37	PH & EF	5	MOH	MOH13	1	1				60	60				100	0	0	0
18/04/2017	10:50	PH & EF	5	STE	STE9	1			1		150			150		0	0	100	0
19/04/2017	09:06	EF	8	STE	STE10	1	1				152	152				100	0	0	0
19/04/2017	09:22	EF	8	SHE	SHE5	1	1				266	20	214	32		8	80	12	0
19/04/2017	09:49	EF	8	SHE	SHE6	1			1		98	25	58	15		26	59	15	0
19/04/2017	09:57	EF	8	KES	KES13	1			1		115	15	100			13	87	0	0
19/04/2017	10:25	EF	8	SHE	SHE7	1			1		243		195	48		0	80	20	0
19/04/2017	10:40	EF	8	SHE	SHE8	1		1			207		207			0	100	0	0
20/04/2017	07:15	EF	4	MAH	MAH32	1		1			112		112			0	100	0	0
20/04/2017	08:55	EF	4	SBZ	SBZ17	2			1		194			194		0	0	100	0
20/04/2017	09:22	EF	4	SHE	SHE9	1			1		438		66	372		0	15	85	0
20/04/2017	10:07	EF	1	HNB	HNB1	3			1		294			155	139	0	0	53	47
23/04/2017	08:39	EF	5	MOH	MOH14	1	1				86	54	32			63	37	0	0
24/04/2017	16:01	EF	9	HEH	HEH3	1	1				63	63				100	0	0	0
27/04/2017	09:04	EF	7	MOH	MOH15	1	1				136	72	64			53	47	0	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
27/04/2017	09:25	EF	7	MOH	MOH16	1	1				51	51				100	0	0	0
27/04/2017	12:00	EF	9	GRV	GRV1	8			1		648			476	172	0	0	73	27
Autumn Survey Period																			
06/09/2017	09:40	CC	1	MOH	MOH1	1	1				95	95				100	0	0	0
06/09/2017	09:42	CC	1	MOH	MOH2	1	1				110	110				100	0	0	0
06/09/2017	13:35	CC	2	STE	STE1	2			1		384			384		0	0	100	0
07/09/2017	12:14	CC	3	STE	STE2	1			1		164			164		0	0	100	0
10/09/2017	08:45	CC	5	MOH	MOH3	1	1				155	155				100	0	0	0
10/09/2017	08:51	CC	5	MOH	MOH4	1	1				172	172				100	0	0	0
10/09/2017	08:58	CC	5	MOH	MOH5	1	1				204	204				100	0	0	0
10/09/2017	09:13	CC	5	MOH	MOH6	1		1			80		80			0	100	0	0
10/09/2017	10:39	CC	5	SBZ	SBZ1	11			1		280			178	102	0	0	64	36
10/09/2017	12:19	CC	6	SBZ	SBZ2	1			1		220			220		0	0	100	0
11/09/2017	08:47	CC	7	MOH	MOH7	1	1				35	35				100	0	0	0
11/09/2017	08:50	CC	7	MOH	MOH8	1	1				222	130	92			59	41	0	0
11/09/2017	09:46	CC	7	SBZ	SBZ3	1	1				45	45				100	0	0	0
11/09/2017	09:59	CC	7	SBZ	SBZ4	1		1			415		415			0	100	0	0
11/09/2017	10:05	CC	7	BOE	BOE1	1			1		532			532		0	0	100	0
13/09/2017	09:04	CC	2	MAH	MAH1	1	1				525	370	155			70	30	0	0
13/09/2017	09:35	CC	2	MAH	MAH2	1		1			392		392			0	100	0	0
13/09/2017	09:57	CC	2	MOH	MOH9	1		1			229		229			0	100	0	0
13/09/2017	10:16	CC	2	HEH	HEH1	1			1		138			138		0	0	100	0
13/09/2017	10:35	CC	2	MAH	MAH3	1		1			164		164			0	100	0	0
14/09/2017	09:01	CC	4	SBZ	SBZ5	1	1				40	40				100	0	0	0
14/09/2017	09:02	CC	4	BLK	BLK1	2	1				168	168				100	0	0	0
14/09/2017	09:05	CC	4	BLK	BLK2	2	1				190	190				100	0	0	0
14/09/2017	09:07	CC	4	SBZ	SBZ6	1		1			209		209			0	100	0	0
14/09/2017	09:09	CC	4	BLK	BLK3	1		1			205		205			0	100	0	0
14/09/2017	09:11	CC	4	MOH	MOH10	1	1				280	280				100	0	0	0
14/09/2017	09:11	CC	4	SBZ	SBZ7	1		1			70		70			0	100	0	0
14/09/2017	09:13	CC	4	SBZ	SBZ8	2			1		115			115		0	0	100	0
14/09/2017	09:15	CC	4	BLK	BLK4	1		1			157		157			0	100	0	0
14/09/2017	09:18	CC	4	BLK	BLK5	2		1			342		342			0	100	0	0

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Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
14/09/2017	09:18	CC	4	SBZ	SBZ9	1		1			409		409			0	100	0	0
14/09/2017	09:20	CC	4	SBZ	SBZ10	3		1			330		330			0	100	0	0
14/09/2017	09:21	CC	4	BLK	BLK6	1	1				178	178				100	0	0	0
14/09/2017	09:26	CC	4	LEK	LEK1	1	1				110	110				100	0	0	0
14/09/2017	09:34	CC	4	MOH	MOH11	1	1				192	192				100	0	0	0
14/09/2017	09:47	CC	4	MOH	MOH12	1	1				88	88				100	0	0	0
14/09/2017	10:11	CC	4	SBZ	SBZ11	1			1		223			223		0	0	100	0
14/09/2017	10:24	CC	4	SBZ	SBZ12	1			1		95			95		0	0	100	0
14/09/2017	10:35	CC	4	SBZ	SBZ13	4			1		142			142		0	0	100	0
14/09/2017	10:36	CC	4	BLK	BLK7	2			1		165			165		0	0	100	0
14/09/2017	10:40	CC	4	SBZ	SBZ14	17			1		963			675	288	0	0	70	30
14/09/2017	10:40	CC	4	LOB	LOB1	2			1		963			675	288	0	0	70	30
14/09/2017	10:40	CC	4	STE	STE3	1			1		720			720		0	0	100	0
14/09/2017	10:48	CC	4	BLK	BLK8	1			1		302			302		0	0	100	0
14/09/2017	10:48	CC	4	MAH	MAH4	1			1		214			214		0	0	100	0
14/09/2017	11:01	CC	4	MOH	MOH13	1	1				139	139				100	0	0	0
14/09/2017	11:52	CC	4	SBZ	SBZ15	1			1		281			281		0	0	100	0
17/09/2017	08:30	CC	6	SBZ	SBZ16	95			1		480			480		0	0	100	0
17/09/2017	08:30	CC	6	HNB	HNB1	4			1		480			480		0	0	100	0
17/09/2017	08:35	CC	6	MOH	MOH14	1		1			224		224			0	100	0	0
17/09/2017	08:45	CC	6	SBZ	SBZ17	87			1		594			594		0	0	100	0
17/09/2017	08:45	CC	6	HNB	HNB2	5			1		594			594		0	0	100	0
17/09/2017	08:50	CC	6	MAH	MAH5	1		1			110		110			0	100	0	0
17/09/2017	08:55	CC	6	SBZ	SBZ18	5		1			252		252			0	100	0	0
17/09/2017	09:00	CC	6	SBZ	SBZ19	115			1		552			552		0	0	100	0
17/09/2017	09:00	CC	6	HNB	HNB3	12			1		552			552		0	0	100	0
17/09/2017	09:03	CC	6	MOH	MOH15	1	1				94	94				100	0	0	0
17/09/2017	09:04	CC	6	MAH	MAH6	2	1				80	80				100	0	0	0
17/09/2017	09:13	CC	6	BLK	BLK9	3			1		168			168		0	0	100	0
17/09/2017	09:15	CC	6	SBZ	SBZ20	195			1		610			610		0	0	100	0
17/09/2017	09:15	CC	6	HNB	HNB4	8			1		610			610		0	0	100	0
17/09/2017	09:15	CC	6	LOB	LOB2	3			1		610			610		0	0	100	0
17/09/2017	09:16	CC	6	SBZ	SBZ21	10		1			155		155			0	100	0	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
17/09/2017	09:23	CC	6	SBZ	SBZ22	17		1			102		102			0	100	0	0
17/09/2017	09:30	CC	6	SBZ	SBZ23	78			1		530			530		0	0	100	0
17/09/2017	09:30	CC	6	HNB	HNB5	11			1		530			530		0	0	100	0
17/09/2017	09:35	CC	6	HNB	HNB6	1		1			115		115			0	100	0	0
17/09/2017	09:41	CC	6	MOH	MOH16	1	1				70	70				100	0	0	0
17/09/2017	09:45	CC	6	SBZ	SBZ24	12			1		505			505		0	0	100	0
18/09/2017	08:28	CC	9	BLK	BLK10	1	1				98	98				100	0	0	0
18/09/2017	08:50	CC	9	SPA	SPA1	1	1				77	77				100	0	0	0
18/09/2017	09:00	CC	9	MAH	MAH7	1	1				560	432	128			77	23	0	0
18/09/2017	09:02	CC	9	BLK	BLK11	1		1			840		840			0	100	0	0
18/09/2017	09:15	CC	9	SBZ	SBZ25	24			1		694			694		0	0	100	0
18/09/2017	09:15	CC	9	HNB	HNB7	2			1		694			694		0	0	100	0
18/09/2017	09:30	CC	9	SBZ	SBZ26	56			1		755			755		0	0	100	0
18/09/2017	09:30	CC	9	STE	STE4	1			1		755			755		0	0	100	0
18/09/2017	09:39	CC	9	SBZ	SBZ27	1			1		240			240		0	0	100	0
18/09/2017	09:43	CC	9	MOH	MOH17	1	1				190	190				100	0	0	0
18/09/2017	09:45	CC	9	SBZ	SBZ28	15			1		582			582		0	0	100	0
18/09/2017	09:45	CC	9	HNB	HNB8	1			1		582			582		0	0	100	0
18/09/2017	09:58	CC	9	MOH	MOH18	1	1				102	102				100	0	0	0
18/09/2017	10:24	CC	9	MAH	MAH8	1		1			249		73	176		0	29	71	0
18/09/2017	12:20	CC	8	SBZ	SBZ29	1				1	307				307	0	0	0	100
19/09/2017	08:45	CC	1	SBZ	SBZ30	38	1				1719	450	674	595		26	39	35	0
19/09/2017	08:45	CC	1	HNB	HNB9	9	1				1719	450	674	595		26	39	35	0
19/09/2017	08:45	CC	1	BLK	BLK12	1	1				1719	450	674	595		26	39	35	0
19/09/2017	09:00	CC	1	SBZ	SBZ31	18	1				1525	520	590	415		34	39	27	0
19/09/2017	09:00	CC	1	HNB	HNB10	4	1				1525	520	590	415		34	39	27	0
19/09/2017	09:15	CC	1	SBZ	SBZ32	21	1				1715	480	725	510		28	42	30	0
19/09/2017	09:15	CC	1	HNB	HNB11	4	1				1715	480	725	510		28	42	30	0
19/09/2017	09:15	CC	1	LOB	LOB3	1	1				1715	480	725	510		28	42	30	0
19/09/2017	09:30	CC	1	SBZ	SBZ33	51	1				1900	350	840	710		18	44	37	0
19/09/2017	09:30	CC	1	HNB	HNB12	6	1				1900	350	840	710		18	44	37	0
19/09/2017	09:45	CC	1	SBZ	SBZ34	13	1				1505	310	520	675		21	35	45	0
19/09/2017	10:00	CC	1	SBZ	SBZ35	74		1			1205		360	845		0	30	70	0

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Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
19/09/2017	10:00	CC	1	HNB	HNB13	3		1			1205		360	845		0	30	70	0
19/09/2017	10:15	CC	1	SBZ	SBZ36	42		1			1365		120	730	515	0	9	53	38
19/09/2017	10:15	CC	1	EGV	EGV1	1		1			1365		120	730	515	0	9	53	38
19/09/2017	10:30	CC	1	SBZ	SBZ37	8	1				945	90	310	545		10	33	58	0
19/09/2017	11:00	CC	1	SBZ	SBZ38	74				1	960				960	0	0	0	100
19/09/2017	11:14	CC	1	MOH	MOH19	1		1			285		60	225		0	21	79	0
19/09/2017	13:32	CC	2	MAH	MAH9	1		1			175		175			0	100	0	0
19/09/2017	13:39	CC	2	SBZ	SBZ39	3				1	534				534	0	0	0	100
20/09/2017	09:23	CC	3	SBZ	SBZ40	3			1		550			550		0	0	100	0
20/09/2017	09:26	CC	3	MOH	MOH20	1		1			184		184			0	100	0	0
20/09/2017	09:30	CC	3	SBZ	SBZ41	1		1			390		390			0	100	0	0
20/09/2017	09:51	CC	3	MAH	MAH10	1	1				249	87	162			35	65	0	0
20/09/2017	10:13	CC	3	BLK	BLK13	1			1		224			224		0	0	100	0
20/09/2017	10:17	CC	3	STE	STE5	2			1		283			283		0	0	100	0
20/09/2017	10:38	CC	3	MAH	MAH11	1			1		200			200		0	0	100	0
20/09/2017	10:41	CC	3	KES	KES1	1		1			55		55			0	100	0	0
20/09/2017	10:48	CC	3	OSP	OSP1	1			1		342			342		0	0	100	0
20/09/2017	10:51	CC	3	BOE	BOE2	1		1			291		291			0	100	0	0
20/09/2017	10:55	CC	3	SBZ	SBZ42	2				1	305				305	0	0	0	100
20/09/2017	10:56	CC	3	MOH	MOH21	1		1			218		218			0	100	0	0
20/09/2017	11:05	CC	3	SBZ	SBZ43	56			1		426			426		0	0	100	0
20/09/2017	11:05	CC	3	MAH	MAH12	3			1		426			426		0	0	0	93
20/09/2017	11:05	CC	3	BLK	BLK14	2			1		426			426		0	0	0	93
20/09/2017	11:12	CC	3	SBZ	SBZ44	49				1	395				395	44	0	0	0
20/09/2017	11:12	CC	3	LOB	LOB4	4				1	395				395	0	0	49	0
20/09/2017	11:19	CC	3	MOH	MOH22	1	1				175	175				0	91	60	0
20/09/2017	11:30	CC	3	SBZ	SBZ45	7			1		195			195		0	82	54	0
20/09/2017	11:34	CC	3	BLK	BLK15	2		1			265		160	105		0	60	40	0
20/09/2017	11:34	CC	3	MAH	MAH13	1		1			265		160	105		0	60	40	0
20/09/2017	11:42	CC	3	SBZ	SBZ46	105			1		500			290	210	0	0	58	42
20/09/2017	11:42	CC	3	BLK	BLK16	3			1		500			290	210	0	0	58	42
21/09/2017	08:23	CC	5	SBZ	SBZ47	126		1			390		390			0	100	0	0
21/09/2017	08:30	CC	5	SBZ	SBZ48	103		1			245		245			0	100	0	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
21/09/2017	08:30	CC	5	SBZ	SBZ49	29		1			320		320			0	100	0	0
21/09/2017	08:37	CC	5	SBZ	SBZ50	62			1		702			702		0	0	100	0
21/09/2017	08:40	CC	5	SBZ	SBZ51	45	1				282	282				100	0	0	0
21/09/2017	08:40	CC	5	HNB	HNB14	2	1				282	282				100	0	0	0
21/09/2017	08:40	CC	5	BLK	BLK17	3	1				282	282				100	0	0	0
21/09/2017	08:50	CC	5	SBZ	SBZ52	32			1		174			174		0	0	100	0
21/09/2017	08:56	CC	5	SBZ	SBZ53	83			1		383			383		0	0	100	0
21/09/2017	08:56	CC	5	HNB	HNB15	2			1		383			383		0	0	100	0
21/09/2017	08:56	CC	5	LOB	LOB5	1			1		383			383		0	0	100	0
21/09/2017	09:04	CC	5	SBZ	SBZ54	12		1			162		162			0	100	0	0
21/09/2017	09:08	CC	5	SBZ	SBZ55	28			1		410			410		0	0	100	0
21/09/2017	09:14	CC	5	SBZ	SBZ56	82			1		246			246		0	0	100	0
21/09/2017	09:14	CC	5	BLK	BLK18	4			1		246			246		0	0	100	0
21/09/2017	09:14	CC	5	HNB	HNB16	3			1		246			246		0	0	100	0
21/09/2017	09:14	CC	5	LOB	LOB6	3			1		246			246		0	0	100	0
21/09/2017	09:21	CC	5	SBZ	SBZ57	123			1		206			206		0	0	100	0
21/09/2017	09:21	CC	5	MAH	MAH14	2			1		206			206		0	0	100	0
21/09/2017	09:21	CC	5	BLK	BLK19	3			1		206			206		0	0	100	0
21/09/2017	09:21	CC	5	HNB	HNB17	2			1		206			206		0	0	100	0
21/09/2017	09:21	CC	5	STE	STE6	1			1		206			206		0	0	100	0
21/09/2017	09:29	CC	5	SBZ	SBZ58	39				1	270				270	0	0	0	100
21/09/2017	09:29	CC	5	BLK	BLK20	1				1	270				270	0	0	0	100
21/09/2017	09:29	CC	5	STE	STE7	1				1	270				270	0	0	0	100
21/09/2017	09:33	CC	5	SBZ	SBZ59	35				1	180				180	0	0	0	100
21/09/2017	09:37	CC	5	SBZ	SBZ60	47			1		146			146		0	0	100	0
21/09/2017	09:37	CC	5	HNB	HNB18	1			1		146			146		0	0	100	0
21/09/2017	09:37	CC	5	BLK	BLK21	2			1		146			146		0	0	100	0
21/09/2017	09:37	CC	5	LOB	LOB7	5			1		146			146		0	0	100	0
21/09/2017	09:40	CC	5	SBZ	SBZ61	58		1			200		200			0	100	0	0
21/09/2017	09:40	CC	5	SPA	SPA2	2		1			200		200			0	100	0	0
21/09/2017	09:40	CC	5	HNB	HNB19	3		1			200		200			0	100	0	0
21/09/2017	09:40	CC	5	MOH	MOH23	1		1			200		200			0	100	0	0
21/09/2017	09:45	CC	5	SBZ	SBZ62	49			1		190			190		0	0	100	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
21/09/2017	09:45	CC	5	BLK	BLK22	1			1		190			190		0	0	100	0
21/09/2017	09:45	CC	5	HNB	HNB20	2			1		190			190		0	0	100	0
21/09/2017	09:47	CC	5	SBZ	SBZ63	24			1		157			157		0	0	100	0
21/09/2017	09:47	CC	5	BOE	BOE3	1			1		157			157		0	0	100	0
21/09/2017	09:50	CC	5	SBZ	SBZ64	23				1	135				135	0	0	0	100
21/09/2017	10:05	CC	5	SBZ	SBZ65	3				1	450				450	0	0	0	100
21/09/2017	10:11	CC	5	SBZ	SBZ66	12				1	130				130	0	0	0	100
21/09/2017	10:11	CC	5	LOB	LOB8	1				1	130				130	0	0	0	100
21/09/2017	10:11	CC	5	BLK	BLK23	1				1	130				130	0	0	0	100
21/09/2017	10:15	CC	5	BLK	BLK24	2			1		152			152		0	0	100	0
21/09/2017	10:17	CC	5	STE	STE8	1			1		178			178		0	0	100	0
21/09/2017	10:20	CC	5	PAH	PAH1	1		1			105		105			0	100	0	0
21/09/2017	10:38	CC	5	STE	STE9	1				1	216				216	0	0	0	100
21/09/2017	10:44	CC	5	STE	STE10	1			1		244			244		0	0	100	0
21/09/2017	13:06	CC	6	SBZ	SBZ67	7				1	164				164	0	0	0	100
24/09/2017	08:30	CC	7	SBZ	SBZ68	5	1				212	212				100	0	0	0
24/09/2017	08:30	CC	7	BLK	BLK25	2	1				212	212				100	0	0	0
24/09/2017	08:38	CC	7	SBZ	SBZ69	21	1				421	421				100	0	0	0
24/09/2017	08:38	CC	7	BLK	BLK26	7	1				421	421				100	0	0	0
24/09/2017	08:50	CC	7	SBZ	SBZ70	3	1				180	180				100	0	0	0
24/09/2017	08:50	CC	7	BLK	BLK27	4	1				180	180				100	0	0	0
24/09/2017	09:02	CC	7	SBZ	SBZ71	16		1			369		369			0	100	0	0
24/09/2017	09:02	CC	7	BLK	BLK28	1		1			369		369			0	100	0	0
24/09/2017	09:11	CC	7	SBZ	SBZ72	12		1			395		395			0	100	0	0
24/09/2017	09:15	CC	7	PAH	PAH2	1	1				80	80				100	0	0	0
24/09/2017	09:21	CC	7	SBZ	SBZ73	5	1				141	141				100	0	0	0
24/09/2017	09:41	CC	7	SBZ	SBZ74	23			1		305			305		0	0	100	0
24/09/2017	09:49	CC	7	SBZ	SBZ75	13		1			316		177	139		0	56	44	0
24/09/2017	09:58	CC	7	SBZ	SBZ76	2		1			241		241			0	100	0	0
24/09/2017	10:54	CC	7	MAH	MAH15	1		1			315		315			0	100	0	0
24/09/2017	14:55	CC	9	MAH	MAH16	1	1				92	92				100	0	0	0
25/09/2017	08:35	CC	8	KES	KES2	1	1				156	156				100	0	0	0
25/09/2017	08:46	CC	8	PAH	PAH3	1	1				182	182				100	0	0	0

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Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
25/09/2017	08:51	CC	8	SBZ	SBZ77	1		1			173		173			0	100	0	0
25/09/2017	09:17	CC	8	SBZ	SBZ78	1	1				160	160				100	0	0	0
25/09/2017	09:26	CC	8	MAH	MAH17	1		1			125		125			0	100	0	0
25/09/2017	10:04	CC	8	STE	STE11	1	1				637	244	393			38	62	0	0
25/09/2017	10:27	CC	8	BLK	BLK29	2			1		210			210		0	0	100	0
25/09/2017	10:36	CC	8	KES	KES3	1	1				226	226				100	0	0	0
25/09/2017	11:21	CC	8	BLK	BLK30	5			1		380			380		0	0	100	0
25/09/2017	11:30	CC	8	BLK	BLK31	1		1			118		118			0	100	0	0
25/09/2017	11:34	CC	8	MAH	MAH18	1	1				98	98				100	0	0	0
25/09/2017	11:41	CC	8	LEK	LEK2	1	1				75	75				100	0	0	0
25/09/2017	14:47	CC	2	PAH	PAH4	1	1				145	145				100	0	0	0
26/09/2017	11:47	CC	7	BLK	BLK32	5	1				112	112				100	0	0	0
26/09/2017	11:50	CC	7	LEK	LEK3	1	1				75	75				100	0	0	0
26/09/2017	11:53	CC	7	HOB	HOB1	1	1				50	50				100	0	0	0
26/09/2017	11:55	CC	7	SBZ	SBZ79	55			1		302			302		0	0	100	0
26/09/2017	12:00	CC	7	SBZ	SBZ80	47		1			210		210			0	100	0	0
26/09/2017	12:00	CC	7	STE	STE12	2		1			210		210			0	100	0	0
26/09/2017	12:00	CC	7	LOB	LOB9	2		1			210		210			0	100	0	0
26/09/2017	12:00	CC	7	LEK	LEK4	2		1			210		210			0	100	0	0
26/09/2017	12:00	CC	7	KES	KES4	1		1			210		210			0	100	0	0
26/09/2017	12:15	CC	7	SBZ	SBZ81	4			1		185			185		0	0	100	0
26/09/2017	12:15	CC	7	LEK	LEK5	2			1		185			185		0	0	100	0
26/09/2017	12:30	CC	7	SBZ	SBZ82	3		1			265		100	165		0	38	62	0
26/09/2017	12:30	CC	7	LEK	LEK6	1		1			265		100	165		0	38	62	0
26/09/2017	12:30	CC	7	PAH	PAH5	1		1			265		100	165		0	38	62	0
26/09/2017	12:47	CC	7	LEK	LEK7	2	1				95	95				100	0	0	0
26/09/2017	13:01	CC	7	LEK	LEK8	1		1			148		148			0	100	0	0
26/09/2017	13:01	CC	7	BOE	BOE4	1		1			148		148			0	100	0	0
26/09/2017	13:08	CC	7	SBZ	SBZ83	3			1		195			195		0	0	100	0
26/09/2017	13:09	CC	7	LEK	LEK9	4		1			184		184			0	100	0	0
26/09/2017	13:25	CC	7	SBZ	SBZ84	29				1	312				312	0	0	0	100
26/09/2017	13:25	CC	7	BLK	BLK33	4				1	312				312	0	0	0	100
26/09/2017	13:31	CC	7	BLK	BLK34	2		1			286		196	90		0	69	31	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
26/09/2017	13:31	CC	7	LES	LES1	1		1			286		196	90		0	69	31	0
26/09/2017	13:41	CC	7	SPA	SPA3	1			1		100			100		0	0	100	0
26/09/2017	13:49	CC	7	SBZ	SBZ85	1		1			250		250			0	100	0	0
26/09/2017	13:49	CC	7	MAH	MAH19	1		1			250		250			0	100	0	0
26/09/2017	14:23	CC	7	SBZ	SBZ86	183				1	574				574	0	0	0	100
26/09/2017	14:41	CC	7	LEK	LEK10	1	1				190	190				100	0	0	0
26/09/2017	14:45	CC	7	SBZ	SBZ87	355				1	308				308	0	0	0	100
26/09/2017	14:45	CC	7	BLK	BLK35	7				1	308				308	0	0	0	100
26/09/2017	14:45	CC	7	BOE	BOE5	3				1	308				308	0	0	0	100
26/09/2017	14:45	CC	7	STE	STE13	1				1	308				308	0	0	0	100
26/09/2017	14:45	CC	7	PAH	PAH6	1		1			308		308			0	100	0	0
26/09/2017	14:45	CC	7	KES	KES5	3		1			308		308			0	100	0	0
26/09/2017	15:44	CC	1	PAH	PAH7	1		1			87		87			0	100	0	0
26/09/2017	16:38	CC	1	PAH	PAH8	1		1			178		178			0	100	0	0
26/09/2017	16:39	CC	1	MAH	MAH20	1			1		192			192		0	0	100	0
26/09/2017	16:42	CC	1	MOH	MOH24	1		1			205		205			0	100	0	0
26/09/2017	16:45	CC	1	MAH	MAH21	2		1			275	25	250			9	91	0	0
26/09/2017	16:51	CC	1	BOE	BOE6	1	1				45	45				100	0	0	0
26/09/2017	16:55	CC	1	MAH	MAH22	1		1			343		343			0	100	0	0
27/09/2017	08:45	CC	3	PAH	PAH9	1	1				115	115				100	0	0	0
27/09/2017	08:46	CC	3	KES	KES6	2	1				92	92				100	0	0	0
27/09/2017	08:50	CC	3	SPA	SPA4	1	1				70	70				100	0	0	0
27/09/2017	08:53	CC	3	MAH	MAH23	1		1			184		184			0	100	0	0
27/09/2017	09:14	CC	3	SBZ	SBZ88	2			1		221			221		0	0	100	0
27/09/2017	09:14	CC	3	BLK	BLK36	1			1		221			221		0	0	100	0
27/09/2017	09:15	CC	3	LEK	LEK11	1	1				58	58				100	0	0	0
27/09/2017	09:21	CC	3	SBZ	SBZ89	6		1			304		210	94		0	69	31	0
27/09/2017	09:21	CC	3	MAH	MAH24	3		1			304		210	94		0	69	31	0
27/09/2017	09:26	CC	3	PAH	PAH10	1	1				164	164				100	0	0	0
27/09/2017	09:30	CC	3	MAH	MAH25	4		1			237		237			0	100	0	0
27/09/2017	09:38	CC	3	SBZ	SBZ90	11			1		397			397		0	0	100	0
27/09/2017	09:38	CC	3	MAH	MAH26	2			1		397			397		0	0	100	0
27/09/2017	09:38	CC	3	KES	KES7	1			1		397			397		0	0	100	0

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Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
27/09/2017	09:41	CC	3	KES	KES8	2		1			102		102			0	100	0	0
27/09/2017	09:49	CC	3	MAH	MAH27	2		1			150		150			0	100	0	0
27/09/2017	09:52	CC	3	SBZ	SBZ91	1			1		218			218		0	0	100	0
27/09/2017	09:59	CC	3	SBZ	SBZ92	13			1		309			309		0	0	100	0
27/09/2017	09:59	CC	3	MAH	MAH28	1			1		309			309		0	0	100	0
27/09/2017	09:59	CC	3	BOE	BOE7	1			1		309			309		0	0	100	0
27/09/2017	10:20	CC	3	MAH	MAH29	1			1		216			216		0	0	100	0
27/09/2017	10:31	CC	3	BLK	BLK37	1				1	284				284	0	0	0	100
27/09/2017	10:31	CC	3	SBZ	SBZ93	1				1	284				284	0	0	0	100
27/09/2017	10:31	CC	3	LOB	LOB10	1				1	284				284	0	0	0	100
27/09/2017	10:44	CC	3	MAH	MAH30	1		1			159		159			0	100	0	0
27/09/2017	10:58	CC	3	STE	STE14	2			1		199			199		0	0	100	0
28/09/2017	08:30	PC	5	BLK	BLK38	1		1			110		110			0	100	0	0
28/09/2017	08:32	PC	5	SBZ	SBZ94	5		1			202		202			0	100	0	0
28/09/2017	08:32	CC	6	BLK	BLK39	1		1			124		124			0	100	0	0
28/09/2017	08:35	PC	5	MAH	MAH31	1	1				175	175				100	0	0	0
28/09/2017	08:42	PC	5	SBZ	SBZ95	1	1				30	30				100	0	0	0
28/09/2017	08:45	PC	5	SBZ	SBZ96	23		1			228		228			0	100	0	0
28/09/2017	08:47	PC	5	SBZ	SBZ97	4		1			214		214			0	100	0	0
28/09/2017	08:50	PC	5	KES	KES9	1	1				70	70				100	0	0	0
28/09/2017	08:52	PC	5	SBZ	SBZ98	44		`	1		650			650		0	0	100	0
28/09/2017	08:54	PC	5	SBZ	SBZ99	3		1			180		180			0	100	0	0
28/09/2017	09:05	PC	5	SBZ	SBZ100	7		1			410		410			0	100	0	0
28/09/2017	09:05	PC	5	EGV	EGV2	1		1			410		410			0	100	0	0
28/09/2017	09:05	PC	5	SPA	SPA5	2		1			410		410			0	100	0	0
28/09/2017	09:05	PC	5	KES	KES10	1		1			410		410			0	100	0	0
28/09/2017	09:05	PC	5	MAH	MAH32	1		1			410		410			0	100	0	0
28/09/2017	09:15	PC	5	SBZ	SBZ101	2			1		360			360		0	0	100	0
28/09/2017	09:25	PC	5	LEK	LEK12	2	1				162	162				100	0	0	0
28/09/2017	09:26	PC	5	SBZ	SBZ102	6			1		300			300		0	0	100	0
28/09/2017	09:28	CC	6	LEK	LEK13	2	1				55	55				100	0	0	0
28/09/2017	09:32	PC	5	SBZ	SBZ103	12	1				290	290				100	0	0	0
28/09/2017	09:42	CC	6	BLK	BLK40	1			1		120			120		0	0	100	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
28/09/2017	09:47	PC	5	LOB	LOB11	1	1				48	48				100	0	0	0
28/09/2017	09:47	PC	5	SPA	SPA6	2	1				90	90				100	0	0	0
28/09/2017	09:49	PC	5	STE	STE15	1			1		342			342		0	0	100	0
28/09/2017	09:49	CC	6	SPA	SPA7	2	1				70	70				100	0	0	0
28/09/2017	09:51	PC	5	SBZ	SBZ104	4			1		315			315		0	0	100	0
28/09/2017	10:02	PC	5	STE	STE16	1			1		38			38		0	0	100	0
28/09/2017	10:03	CC	6	STE	STE17	1			1		146			146		0	0	100	0
28/09/2017	10:15	PC	5	SBZ	SBZ105	4			1		236			236		0	0	100	0
28/09/2017	10:22	PC	5	PAH	PAH11	2		1			92		92			0	100	0	0
28/09/2017	10:24	CC	6	PAH	PAH12	2		1			87		87			0	100	0	0
28/09/2017	10:27	PC	5	KES	KES11	1	1				155	155				100	0	0	0
28/09/2017	11:10	PC	5	MAH	MAH33	1		1			112		112			0	100	0	0
28/09/2017	12:34	PC	9	SBZ	SBZ106	7			1		197			197		0	0	100	0
28/09/2017	12:38	CC	8	SBZ	SBZ107	7			1		182			182		0	0	100	0
28/09/2017	14:06	PC	9	PAH	PAH13	1			1		139			139		0	0	100	0
28/09/2017	14:09	CC	8	PAH	PAH14	1			1		178			178		0	0	100	0
28/09/2017	14:22	PC	9	SBZ	SBZ108	2			1		184			184		0	0	100	0
28/09/2017	14:25	CC	8	SBZ	SBZ109	2			1		188			188		0	0	100	0
01/10/2017	08:19	CC & PC	1	PAH	PAH15	1	1				164	164				100	0	0	0
01/10/2017	08:22	CC & PC	1	MAH	MAH34	1	1				182	182				100	0	0	0
01/10/2017	08:23	CC & PC	1	LEK	LEK14	1	1				89	89				100	0	0	0
01/10/2017	08:23	CC & PC	1	KES	KES12	1	1				89	89				100	0	0	0
01/10/2017	08:37	CC & PC	1	PAH	PAH16	1	1				47	47				100	0	0	0
01/10/2017	08:54	CC & PC	1	SBZ	SBZ110	37			1		567			567		0	0	100	0
01/10/2017	08:54	CC & PC	1	STE	STE18	1			1		567			567		0	0	100	0
01/10/2017	08:54	CC & PC	1	MAH	MAH35	1			1		567			567		0	0	100	0
01/10/2017	08:55	CC & PC	1	KES	KES13	1		1			105		105			0	100	0	0
01/10/2017	09:05	CC & PC	1	SBZ	SBZ111	28			1		660			660		0	0	100	0
01/10/2017	09:12	CC & PC	1	SBZ	SBZ112	179			1		545			545		0	0	100	0
01/10/2017	09:12	CC & PC	1	HNB	HNB21	13			1		545			545		0	0	100	0
01/10/2017	09:12	CC & PC	1	MAH	MAH36	6			1		545			545		0	0	100	0
01/10/2017	09:12	CC & PC	1	PAH	PAH17	1			1		545			545		0	0	100	0
01/10/2017	09:12	CC & PC	1	BLK	BLK41	3			1		545			545		0	0	100	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
01/10/2017	09:12	CC & PC	1	LOB	LOB12	1			1		545			545		0	0	100	0
01/10/2017	09:30	CC & PC	1	SBZ	SBZ113	202			1		205			205		0	0	100	0
01/10/2017	09:30	CC & PC	1	HNB	HNB22	45			1		205			205		0	0	100	0
01/10/2017	09:30	CC & PC	1	MAH	MAH37	3			1		205			205		0	0	100	0
01/10/2017	09:30	CC & PC	1	STE	STE19	1			1		205			205		0	0	100	0
01/10/2017	09:30	CC & PC	1	LEE	LEE1	1			1		205			205		0	0	100	0
01/10/2017	09:31	CC & PC	1	SBZ	SBZ114	71			1		215			215		0	0	100	0
01/10/2017	09:31	CC & PC	1	PAH	PAH18	1			1		215			215		0	0	100	0
01/10/2017	09:31	CC & PC	1	STE	STE20	1			1		215			215		0	0	100	0
01/10/2017	09:32	CC & PC	1	SBZ	SBZ115	77			1		332			332		0	0	100	0
01/10/2017	09:32	CC & PC	1	HNB	HNB23	10			1		332			332		0	0	100	0
01/10/2017	09:32	CC & PC	1	PUH	PUH1	19			1		407			407		0	0	100	0
01/10/2017	09:39	CC & PC	1	STE	STE21	1			1		198			198		0	0	100	0
01/10/2017	09:47	CC & PC	1	SBZ	SBZ116	126			1		275			275		0	0	100	0
01/10/2017	09:47	CC & PC	1	HNB	HNB24	9			1		275			275		0	0	100	0
01/10/2017	09:47	CC & PC	1	STE	STE22	2			1		275			275		0	0	100	0
01/10/2017	09:47	CC & PC	1	BOE	BOE8	1			1		275			275		0	0	100	0
01/10/2017	09:54	CC & PC	1	STE	STE23	1			1		195			195		0	0	100	0
01/10/2017	10:47	CC & PC	1	STE	STE24	1	1				731	120	85	312	214	16	12	43	29
01/10/2017	10:55	CC & PC	1	SBZ	SBZ117	2				1	204				204	0	0	0	100
02/10/2017	07:17	PC	4	MAH	MAH38	1	1				93	93				100	0	0	0
02/10/2017	07:58	PC	4	PAH	PAH19	1	1				148	148				100	0	0	0
02/10/2017	08:06	PC	4	KES	KES14	1	1				62	62				100	0	0	0
02/10/2017	08:11	PC	4	MAH	MAH39	1	1				81	81				100	0	0	0
02/10/2017	08:16	PC	4	PAH	PAH20	1	1				86	86				100	0	0	0
02/10/2017	08:20	PC	4	PAH	PAH21	1	1				40	40				100	0	0	0
02/10/2017	08:32	PC	4	SBZ	SBZ118	2		1			74		74			0	100	0	0
02/10/2017	08:38	PC	4	MAH	MAH40	1	1				96	96				100	0	0	0
02/10/2017	08:42	PC	4	PAH	PAH22	1	1				50	50				100	0	0	0
02/10/2017	08:55	PC	4	PAH	PAH23	1	1				109	109				100	0	0	0
02/10/2017	09:01	PC	4	SBZ	SBZ119	1		1			38		38			0	100	0	0
02/10/2017	09:04	PC	4	MAH	MAH41	1	1				47	47				100	0	0	0
02/10/2017	09:06	PC	4	LEK	LEK15	1	1				24	24				100	0	0	0

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Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
02/10/2017	09:23	PC	4	EGV	EGV3	1			1		221			221		0	0	100	0
02/10/2017	09:33	PC	4	MAH	MAH42	1		1			87		87			0	100	0	0
02/10/2017	09:49	PC	4	SBZ	SBZ120	17		1			109		109			0	100	0	0
02/10/2017	12:04	PC	5	HNB	HNB25	2			1		245			245		0	0	100	0
02/10/2017	12:09	PC	5	SBZ	SBZ121	1			1		133			133		0	0	100	0
02/10/2017	12:14	PC	5	MAH	MAH43	1			1		90			90		0	0	100	0
02/10/2017	12:28	PC	5	LEE	LEE2	1			1		67			67		0	0	100	0
02/10/2017	13:22	PC	5	SBZ	SBZ122	7			1		199			199		0	0	100	0
03/10/2017	08:08	PC	6	KES	KES15	1	1				36	36				100	0	0	0
03/10/2017	08:17	PC	6	PAH	PAH24	1	1				102	102				100	0	0	0
03/10/2017	08:39	PC	6	KES	KES16	1	1				55	55				100	0	0	0
03/10/2017	09:37	PC	6	SBZ	SBZ123	78			1		269			269		0	0	100	0
03/10/2017	09:37	PC	6	HNB	HNB26	5			1		269			269		0	0	100	0
03/10/2017	09:37	PC	6	BLK	BLK42	3			1		269			269		0	0	100	0
03/10/2017	09:46	PC	6	SBZ	SBZ124	56			1		191			191		0	0	100	0
03/10/2017	09:51	PC	6	SBZ	SBZ125	33			1		162			162		0	0	100	0
03/10/2017	09:54	PC	6	SBZ	SBZ126	12			1		96			96		0	0	100	0
03/10/2017	10:00	PC	6	SBZ	SBZ127	29			1		125			125		0	0	100	0
03/10/2017	10:11	PC	6	SBZ	SBZ128	104			1		288			288		0	0	100	0
03/10/2017	10:11	PC	6	LOB	LOB13	2			1		288			288		0	0	100	0
03/10/2017	10:11	PC	6	BLK	BLK43	6			1		288			288		0	0	100	0
03/10/2017	10:29	PC	6	SBZ	SBZ129	14			1		183			183		0	0	100	0
03/10/2017	12:06	PC	7	KES	KES17	1		1			77		77			0	100	0	0
03/10/2017	13:27	PC	7	MAH	MAH44	1			1		112			112		0	0	100	0
03/10/2017	14:14	PC	7	STE	STE25	1			1		166			166		0	0	100	0
04/10/2017	08:06	PC	8	SBZ	SBZ130	21			1		123			123		0	0	100	0
04/10/2017	08:11	PC	8	PAH	PAH25	1	1				84	84				100	0	0	0
04/10/2017	08:17	PC	8	SBZ	SBZ131	220			1		260			260		0	0	100	0
04/10/2017	08:17	PC	8	MAH	MAH45	7			1		260			260		0	0	100	0
04/10/2017	08:17	PC	8	HNB	HNB27	4			1		260			260		0	0	100	0
04/10/2017	08:21	PC	8	LOB	LOB14	1			1		105			105		0	0	100	0
04/10/2017	08:27	PC	8	SBZ	SBZ132	42			1		139			139		0	0	100	0
04/10/2017	08:30	PC	8	SBZ	SBZ133	4	1				95	95				100	0	0	0

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Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
04/10/2017	08:38	PC	8	STE	STE26	2			1		155			155		0	0	100	0
04/10/2017	08:44	PC	8	PAH	PAH26	1	1				66	66				100	0	0	0
04/10/2017	08:58	PC	8	SBZ	SBZ134	16			1		120			120		0	0	100	0
04/10/2017	09:07	PC	8	SBZ	SBZ135	26			1		171			171		0	0	100	0
04/10/2017	09:07	PC	8	HNB	HNB28	3			1		171			171		0	0	100	0
04/10/2017	09:19	PC	8	SBZ	SBZ136	38			1		158			158		0	0	100	0
04/10/2017	09:29	PC	8	KES	KES18	1	1				39	39				100	0	0	0
04/10/2017	09:44	PC	8	SBZ	SBZ137	20			1		160			160		0	0	100	0
04/10/2017	10:18	PC	8	SBZ	SBZ138	14			1		134			134		0	0	100	0
04/10/2017	11:46	PC	9	KES	KES19	2		1			140		140			0	100	0	0
04/10/2017	12:13	PC	9	EGV	EGV4	1			1		197			197		0	0	100	0
04/10/2017	12:50	PC	9	SBZ	SBZ139	4			1		86			86		0	0	100	0
04/10/2017	13:27	PC	9	SHE	SHE1	1			1		51			51		0	0	100	0
04/10/2017	13:56	PC	9	EGV	EGV5	1			1		145			145		0	0	100	0
05/10/2017	07:56	PC	1	KES	KES20	1	1				47	47				100	0	0	0
05/10/2017	08:05	PC	1	SBZ	SBZ140	7		1			139		139			0	100	0	0
05/10/2017	08:34	PC	1	LEE	LEE3	1			1		162			162		0	0	100	0
05/10/2017	08:34	PC	1	MAH	MAH46	1			1		162			162		0	0	100	0
05/10/2017	08:34	PC	1	SBZ	SBZ141	5			1		162			162		0	0	100	0
05/10/2017	08:40	PC	1	PAH	PAH27	1	1				109	109				100	0	0	0
05/10/2017	08:52	PC	1	KES	KES21	1	1				58	58				100	0	0	0
05/10/2017	09:28	PC	1	BLK	BLK44	1			1		95			95		0	0	100	0
05/10/2017	09:35	PC	1	SBZ	SBZ142	4			1		157			157		0	0	100	0
05/10/2017	09:53	PC	1	PAH	PAH28	1	1				116	116				100	0	0	0
05/10/2017	10:14	PC	1	STE	STE27	1			1		223			223		0	0	100	0
05/10/2017	12:08	PC	2	SBZ	SBZ143	2			1		127			127		0	0	100	0
08/10/2017	08:10	PC	3	MAH	MAH47	1	1				49	49				100	0	0	0
08/10/2017	08:38	PC	3	PAH	PAH29	1	1				37	37				100	0	0	0
08/10/2017	08:44	PC	3	SBZ	SBZ144	1		1			67	67				100	0	0	0
08/10/2017	08:56	PC	3	SBZ	SBZ145	29			1		253			253		0	0	100	0
08/10/2017	08:56	PC	3	BLK	BLK45	6			1		253			253		0	0	100	0
08/10/2017	08:56	PC	3	BOE	BOE9	1			1		253			253		0	0	100	0
08/10/2017	09:04	PC	3	SBZ	SBZ146	7			1		147			147		0	0	100	0

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08/10/2017	09:13	PC	3	SBZ	SBZ147	13			1		195			195		0	0	100	0
08/10/2017	09:13	PC	3	LOB	LOB15	1			1		195			195		0	0	100	0
08/10/2017	09:19	PC	3	HNB	HNB29	2			1		166			166		0	0	100	0
08/10/2017	09:19	PC	3	BLK	BLK46	1			1		166			166		0	0	100	0
08/10/2017	09:28	PC	3	BOE	BOE10	1			1		184			184		0	0	100	0
08/10/2017	09:53	PC	3	SBZ	SBZ148	1			1		150			150		0	0	100	0
08/10/2017	10:09	PC	3	SBZ	SBZ149	12			1		202			202		0	0	100	0
08/10/2017	10:35	PC	3	SBZ	SBZ150	9			1		170			170		0	0	100	0
08/10/2017	10:35	PC	3	MAH	MAH48	1			1		170			170		0	0	100	0
08/10/2017	12:07	PC	4	STE	STE28	1			1		309			309		0	0	100	0
08/10/2017	12:23	PC	4	SBZ	SBZ151	23			1		292			292		0	0	100	0
08/10/2017	12:23	PC	4	LOB	LOB16	1			1		292			292		0	0	100	0
08/10/2017	12:23	PC	4	SPA	SPA8	1			1		292			292		0	0	100	0
08/10/2017	12:52	PC	4	KES	KES22	1	1				40	40				100	0	0	0
08/10/2017	13:13	PC	4	LEK	LEK16	1		1			96	31	65			32	68	0	0
08/10/2017	13:34	PC	4	SBZ	SBZ152	1				1	59				59	0	0	0	100
09/10/2017	07:17	PC	1	KES	KES23	1	1				25	25				100	0	0	0
09/10/2017	07:29	PC	1	HEH	HEH2	1	1				148	148				100	0	0	0
09/10/2017	07:46	PC	1	PAH	PAH30	1	1				69	69				100	0	0	0
09/10/2017	08:09	PC	1	PAH	PAH31	2	1				133	133				100	0	0	0
09/10/2017	08:13	PC	1	KES	KES24	1	1				63	63				100	0	0	0
09/10/2017	08:16	PC	1	PAH	PAH32	2	1				97	97				100	0	0	0
09/10/2017	08:22	PC	1	PAH	PAH33	1	1				130	130				100	0	0	0
09/10/2017	08:27	PC	1	LOB	LOB17	1		1			77		77			0	100	0	0
09/10/2017	08:43	PC	1	LEK	LEK17	1	1				81	81				100	0	0	0
09/10/2017	09:18	PC	1	SBZ	SBZ153	4			1		184			184		0	0	100	0
09/10/2017	09:23	PC	1	PAH	PAH34	1	1				116	116				100	0	0	0
09/10/2017	09:29	PC	1	PAH	PAH35	1	1				93	93				100	0	0	0
09/10/2017	09:36	PC	1	PAH	PAH36	1	1				100	100				100	0	0	0
09/10/2017	09:40	PC	1	PAH	PAH37	1		1			88		88			0	100	0	0
09/10/2017	09:44	PC	1	PAH	PAH38	1	1				56	56				100	0	0	0
09/10/2017	11:57	PC	5	PAH	PAH39	1	1				128	128				100	0	0	0
09/10/2017	12:21	PC	5	SBZ	SBZ154	7			1		226			226		0	0	100	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
09/10/2017	12:29	PC	5	PAH	PAH40	1	1				83	83				100	0	0	0
09/10/2017	12:37	PC	5	PAH	PAH41	1	1				27	27				100	0	0	0
09/10/2017	12:48	PC	5	SBZ	SBZ155	3	1				94			94		0	0	100	0
09/10/2017	12:56	PC	5	PAH	PAH42	1			1		140	140				100	0	0	0
09/10/2017	13:13	PC	5	PAH	PAH43	1	1				106	106				100	0	0	0
10/10/2017	07:49	PC	6	PAH	PAH44	1	1				58	58				100	0	0	0
10/10/2017	07:54	PC	6	MAH	MAH49	1	1				89	89				100	0	0	0
10/10/2017	08:03	PC	6	SBZ	SBZ156	4		1			106		106			0	100	0	0
10/10/2017	08:09	PC	6	PAH	PAH45	1	1				64	64				100	0	0	0
10/10/2017	08:18	PC	6	SBZ	SBZ157	3			1		123			123		0	0	100	0
10/10/2017	08:21	PC	6	PAH	PAH46	1	1				77	77				100	0	0	0
10/10/2017	08:24	PC	6	SBZ	SBZ158	27			1		102			102		0	0	100	0
10/10/2017	08:28	PC	6	SBZ	SBZ159	18			1		97			97		0	0	100	0
10/10/2017	08:30	PC	6	MAH	MAH50	1	1				31	31				100	0	0	0
10/10/2017	08:34	PC	6	SBZ	SBZ160	9		1			111		111			0	100	0	0
10/10/2017	08:38	PC	6	SBZ	SBZ161	22			1		164			164		0	0	100	0
10/10/2017	08:43	PC	6	PAH	PAH47	1	1				95	95				100	0	0	0
10/10/2017	08:46	PC	6	LOB	LOB18	1			1		86			86		0	0	100	0
10/10/2017	08:47	PC	6	PAH	PAH48	1	1				36	36				100	0	0	0
10/10/2017	08:52	PC	6	SBZ	SBZ162	17			1		122			122		0	0	100	0
10/10/2017	08:52	PC	6	BLK	BLK47	2			1		122			122		0	0	100	0
10/10/2017	08:53	PC	6	PAH	PAH49	1	1				48	48				100	0	0	0
10/10/2017	08:55	PC	6	PAH	PAH50	1	1				52	52				100	0	0	0
10/10/2017	08:57	PC	6	SBZ	SBZ163	10		1			74		74			0	100	0	0
10/10/2017	09:02	PC	6	SBZ	SBZ164	38			1		126			126		0	0	100	0
10/10/2017	09:06	PC	6	SBZ	SBZ165	13			1		85			85		0	0	100	0
10/10/2017	09:09	PC	6	SBZ	SBZ166	31			1		105			105		0	0	100	0
10/10/2017	09:17	PC	6	SBZ	SBZ167	14			1		96			96		0	0	100	0
10/10/2017	09:26	PC	6	STE	STE29	1			1		218			218		0	0	100	0
10/10/2017	09:32	PC	6	PAH	PAH51	1	1				40	40				100	0	0	0
10/10/2017	09:36	PC	6	SBZ	SBZ168	17			1		143			143		0	0	100	0
10/10/2017	09:39	PC	6	PAH	PAH52	1	1				51	51				100	0	0	0
10/10/2017	09:45	PC	6	SBZ	SBZ169	8		1			190		62	128		0	33	67	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
10/10/2017	09:49	PC	6	STE	STE30	1			1		233			233		0	0	100	0
10/10/2017	10:00	PC	6	SBZ	SBZ170	13			1		190			190		0	0	100	0
10/10/2017	10:06	PC	6	PAH	PAH53	1			1		178			178		0	0	100	0
10/10/2017	10:10	PC	6	PAH	PAH54	1	1				61	61				100	0	0	0
10/10/2017	10:13	PC	6	SBZ	SBZ171	9			1		116			116		0	0	100	0
10/10/2017	10:27	PC	6	PAH	PAH55	1			1		137			137		0	0	100	0
10/10/2017	11:28	PC	7	LOB	LOB19	1			1		275			275		0	0	100	0
10/10/2017	11:32	PC	7	BOE	BOE11	2			1		239			239		0	0	100	0
10/10/2017	11:38	PC	7	SBZ	SBZ172	6			1		220			220		0	0	100	0
10/10/2017	11:38	PC	7	SAF	SAF1	1			1		220			220		0	0	100	0
10/10/2017	12:04	PC	7	BLK	BLK48	2			1		15			15		0	0	100	0
10/10/2017	12:31	PC	7	STE	STE31	1			1		149			149		0	0	100	0
10/10/2017	14:03	PC	7	SBZ	SBZ173	1			1		54			54		0	0	100	0
11/10/2017	06:34	PC	9	PAH	PAH56	1	1				55	55				100	0	0	0
11/10/2017	06:41	PC	9	MAH	MAH51	1	1				48	48				100	0	0	0
11/10/2017	07:38	PC	9	PAH	PAH57	1	1				137	137				100	0	0	0
11/10/2017	07:44	PC	9	MAH	MAH52	1	1				96	96				100	0	0	0
11/10/2017	07:49	PC	9	PAH	PAH58	1	1				108	108				100	0	0	0
11/10/2017	07:56	PC	9	PAH	PAH59	1	1				84	84				100	0	0	0
11/10/2017	08:07	PC	9	PAH	PAH60	1	1				102	102				100	0	0	0
11/10/2017	08:12	PC	9	BLK	BLK49	1		1			122		122			0	100	0	0
11/10/2017	08:28	PC	9	SBZ	SBZ174	12			1		176			176		0	0	100	0
11/10/2017	08:42	PC	9	SBZ	SBZ175	7		1			147		147			0	100	0	0
11/10/2017	08:52	PC	9	SBZ	SBZ176	3			1		174			174		0	0	100	0
11/10/2017	08:56	PC	9	LOB	LOB20	1			1		192			192		0	0	100	0
11/10/2017	09:10	PC	9	STE	STE32	1			1		391			391		0	0	100	0
11/10/2017	09:19	PC	9	KES	KES25	1	1				62			62		0	0	100	0
11/10/2017	10:00	PC	2	BOE	BOE12	1			1		262			262		0	0	100	0
11/10/2017	10:06	PC	2	SBZ	SBZ177	5			1		196			196		0	0	100	0
11/10/2017	10:08	PC	2	STE	STE33	1			1		226			226		0	0	100	0
11/10/2017	10:17	PC	2	SBZ	SBZ178	4			1		164			164		0	0	100	0
11/10/2017	10:30	PC	2	SPA	SPA9	1			1		211			211		0	0	100	0
11/10/2017	10:39	PC	2	SBZ	SBZ179	3			1		206			206		0	0	100	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
11/10/2017	10:54	PC	2	KES	KES26	1	1				28	28				100	0	0	0
11/10/2017	11:11	PC	2	SBZ	SBZ180	9		1			299		100	199		0	33	67	0
11/10/2017	11:23	PC	2	KES	KES27	1	1				42	42				100	0	0	0
11/10/2017	11:53	PC	2	KES	KES28	1	1				63	63				100	0	0	0
11/10/2017	12:02	PC	2	PAH	PAH61	1				1	155				155	0	0	0	100
11/10/2017	12:40	PC	2	KES	KES29	1	1				77	77				100	0	0	0
11/10/2017	15:47	PC	3	HNB	HNB30	1			1		88			88		0	0	100	0
11/10/2017	15:53	PC	3	HNB	HNB31	5			1		116			116		0	0	100	0
11/10/2017	15:58	PC	3	MAH	MAH53	1		1			63		63			0	100	0	0
11/10/2017	16:06	PC	3	SBZ	SBZ181	3			1		92			92		0	0	100	0
16/10/2017	07:56	PC	4	KES	KES30	1		1			57		57			0	100	0	0
16/10/2017	08:12	PC	4	PAH	PAH62	1	1				129	129				100	0	0	0
16/10/2017	08:47	PC	4	PAH	PAH63	1	1				158	158				100	0	0	0
16/10/2017	09:01	PC	4	MAH	MAH54	1		1			48		48			0	100	0	0
16/10/2017	09:11	PC	4	PAH	PAH64	1	1				68	68				100	0	0	0
16/10/2017	09:16	PC	4	PAH	PAH65	1	1				136	136				100	0	0	0
16/10/2017	09:27	PC	4	LEK	LEK18	1		1			145		145			0	100	0	0
16/10/2017	09:39	PC	4	PAH	PAH66	1	1				141	141				100	0	0	0
16/10/2017	09:43	PC	4	SBZ	SBZ182	1		1			166		166			0	100	0	0
16/10/2017	10:16	PC	5	PAH	PAH67	1	1				52	52				100	0	0	0
16/10/2017	10:21	PC	5	HOB	HOB2	1	1				65		65			0	100	0	0
16/10/2017	10:27	PC	5	STE	STE34	1			1		161			161		0	0	100	0
16/10/2017	10:33	PC	5	BLK	BLK50	1			1		118			118		0	0	100	0
16/10/2017	10:37	PC	5	EIE	EIE1	1		1			97		97			0	100	0	0
16/10/2017	10:50	PC	5	STE	STE35	1		1			46		46			0	100	0	0
16/10/2017	11:18	PC	5	MAH	MAH55	1		1			66		66			0	100	0	0
16/10/2017	11:29	PC	5	MAH	MAH56	1			1		238			238		0	0	100	0
16/10/2017	11:48	PC	5	BLK	BLK51	2			1		182			182		0	0	100	0
16/10/2017	12:12	PC	5	STE	STE36	1			1		210			210		0	0	100	0
16/10/2017	12:20	PC	5	BOE	BOE13	1			1		134			134		0	0	100	0
16/10/2017	12:47	PC	5	STE	STE37	1			1		125			125		0	0	100	0
16/10/2017	16:07	PC	6	LEK	LEK19	1			1		143			143		0	0	100	0
17/10/2017	06:51	PC	7	KES	KES31	1		1			49		49			0	100	0	0

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
17/10/2017	06:58	PC	7	PAH	PAH68	1	1				39	39				100	0	0	0
17/10/2017	07:15	PC	7	PAH	PAH69	1	1				72	72				100	0	0	0
17/10/2017	07:24	PC	7	PAH	PAH70	1		1			103	15	88			15	85	0	0
17/10/2017	07:31	PC	7	PAH	PAH71	1	1				63	63				100	0	0	0
17/10/2017	07:37	PC	7	PAH	PAH72	1		1			115	20	95			17	83	0	0
17/10/2017	08:18	PC	7	KES	KES32	1		1			51		51			0	100	0	0
17/10/2017	08:29	PC	7	SBZ	SBZ183	8			1		206			206		0	0	100	0
17/10/2017	08:57	PC	7	PAH	PAH73	1			1		126	18		108		14	0	86	0
17/10/2017	09:16	PC	7	SBZ	SBZ184	4			1		192			192		0	0	100	0
17/10/2017	09:26	PC	7	PAH	PAH74	1		1			93	23	70			25	75	0	0
18/10/2017	07:04	PC	1	PAH	PAH75	1	1				54	54				100	0	0	0
18/10/2017	07:20	PC	1	KES	KES33	1	1				62	62				100	0	0	0
18/10/2017	07:41	PC	1	PAH	PAH76	1	1				268	147	121			55	45	0	0
18/10/2017	07:47	PC	1	PAH	PAH77	1	1				73	73				100	0	0	0
18/10/2017	08:16	PC	1	PAH	PAH78	1	1				86	86				100	0	0	0
18/10/2017	08:21	PC	1	PAH	PAH79	1	1				105	105				100	0	0	0
18/10/2017	08:31	PC	1	PAH	PAH80	1	1				97	97				100	0	0	0
18/10/2017	08:47	PC	1	KES	KES34	1		1			101	33	68			33	67	0	0
18/10/2017	09:02	PC	1	PAH	PAH81	1	1				66	66				100	0	0	0
18/10/2017	09:09	PC	1	KES	KES35	1	1				29	29				100	0	0	0
18/10/2017	09:18	PC	1	KES	KES36	2	1				61	61				100	0	0	0
18/10/2017	09:23	PC	1	KES	KES37	1	1				71	71				100	0	0	0
18/10/2017	09:37	PC	1	PAH	PAH82	1	1				108	108				100	0	0	0
18/10/2017	09:45	PC	1	BLK	BLK52	1			1		233			233		0	0	100	0
18/10/2017	09:56	PC	1	PAH	PAH83	1	1				111	63	48			57	43	0	0
18/10/2017	10:31	PC	2	KES	KES38	1		1			44		44			0	100	0	0
18/10/2017	10:37	PC	2	PAH	PAH84	1	1				77	77				100	0	0	0
18/10/2017	10:49	PC	2	MAH	MAH57	1			1		163			163		0	0	100	0
18/10/2017	11:11	PC	2	BLK	BLK53	2			1		214			214		0	0	100	0
18/10/2017	11:18	PC	2	KES	KES39	1		1			99		99			0	100	0	0
18/10/2017	11:37	PC	2	STE	STE38	1			1		186			186		0	0	100	0
18/10/2017	12:23	PC	2	KES	KES40	1	1				70	70				100	0	0	0
19/10/2017	07:20	PC	3	PAH	PAH85	1	1				92	92				100	0	0	0

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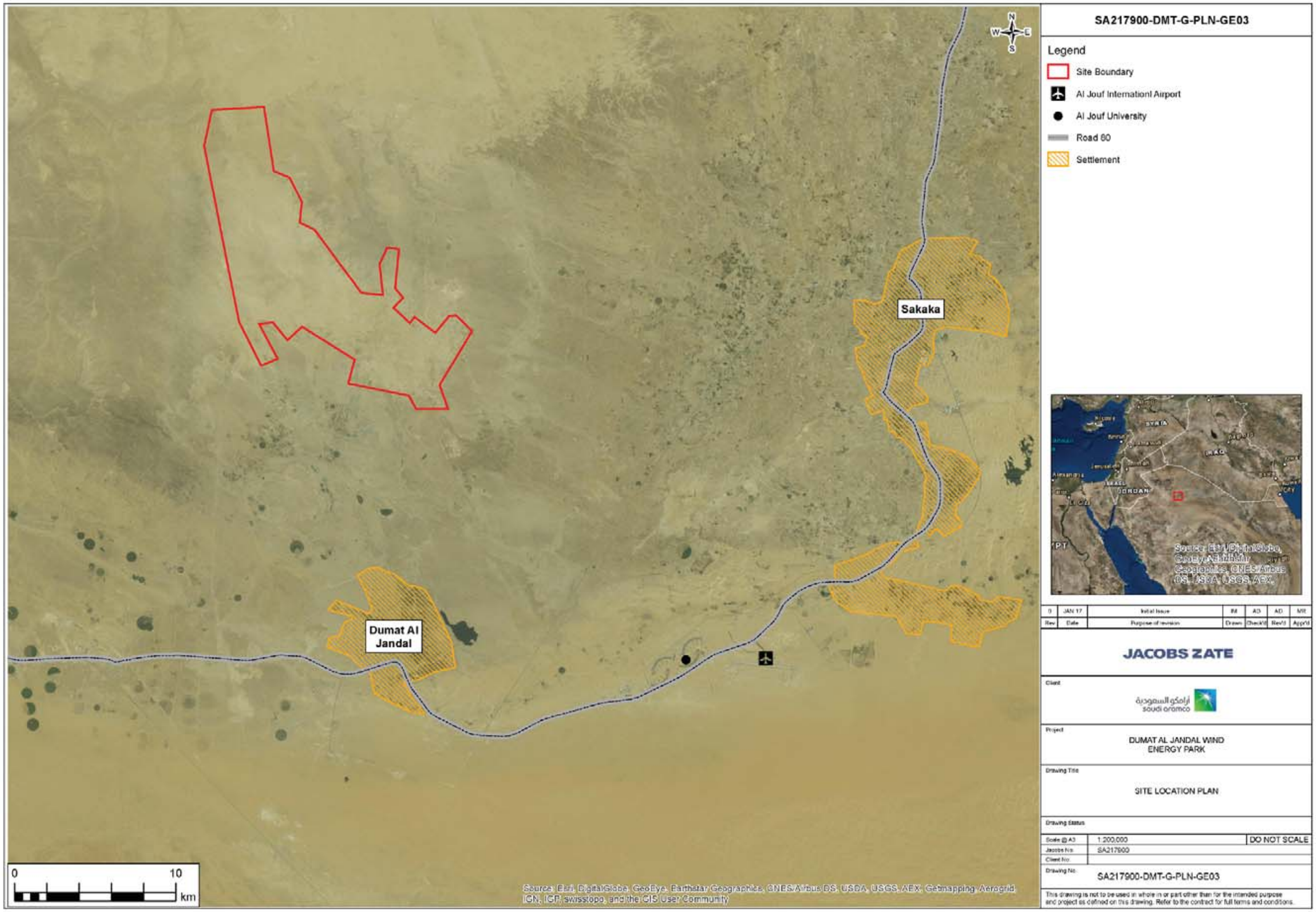
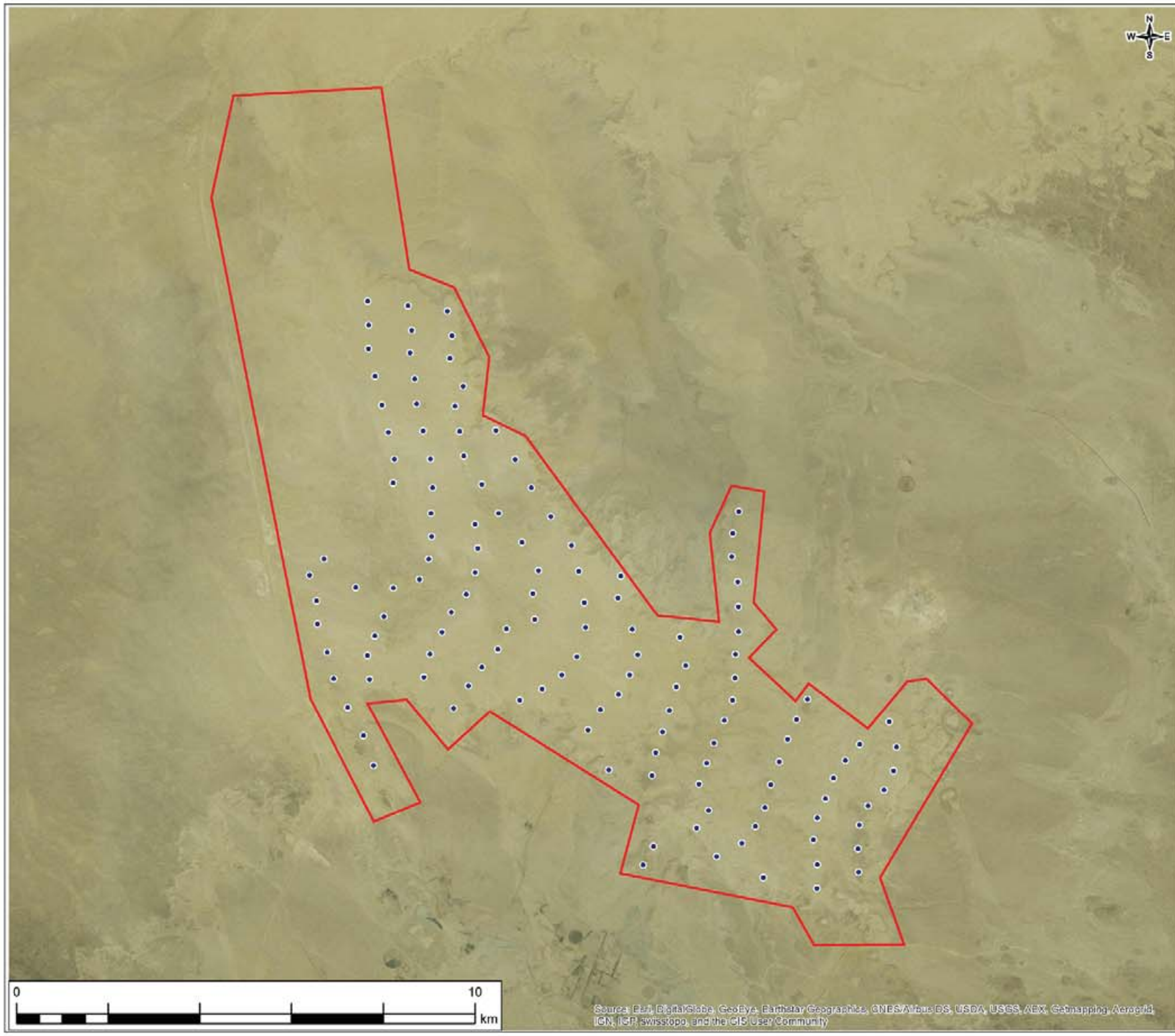
Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
19/10/2017	07:48	PC	3	SBZ	SBZ185	2		1			118		118			0	100	0	0
19/10/2017	08:03	PC	3	SBZ	SBZ186	1		1			134		134			0	100	0	0
19/10/2017	08:21	PC	3	KES	KES41	1		1			125		125			0	100	0	0
19/10/2017	08:29	PC	3	KES	KES42	1		1			114		114			0	100	0	0
19/10/2017	08:41	PC	3	MAH	MAH58	1			1		192			192		0	0	100	0
19/10/2017	08:47	PC	3	KES	KES43	1	1				43	43				100	0	0	0
19/10/2017	08:50	PC	3	KES	KES44	1		1			148		148			0	100	0	0
19/10/2017	09:06	PC	3	SBZ	SBZ187	1			1		204			204		0	0	100	0
19/10/2017	09:14	PC	3	SBZ	SBZ188	1	1				73	73				100	0	0	0
19/10/2017	09:19	PC	3	SBZ	SBZ189	2			1		177			177		0	0	100	0
19/10/2017	09:24	PC	3	KES	KES45	1	1				84	84				100	0	0	0
19/10/2017	09:29	PC	3	PAH	PAH86	1	1				78	78				100	0	0	0
19/10/2017	09:33	PC	3	STE	STE39	2			1		268			268		0	0	100	0
19/10/2017	09:33	PC	3	EGV	EGV6	1			1		268			268		0	0	100	0
19/10/2017	09:45	PC	3	BOE	BOE14	1			1		217			217		0	0	100	0
19/10/2017	09:56	PC	3	EIE	EIE2	1			1		307			307		0	0	100	0
19/10/2017	10:46	PC	4	KES	KES46	1	1				70	70				100	0	0	0
19/10/2017	10:52	PC	4	SBZ	SBZ190	3			1		130			130		0	0	100	0
19/10/2017	10:59	PC	4	KES	KES47	1			1		92			92		0	0	100	0
19/10/2017	11:13	PC	4	SBZ	SBZ191	1			1		116			116		0	0	100	0
19/10/2017	11:32	PC	4	STE	STE40	1			1		198			198		0	0	100	0
19/10/2017	11:50	PC	4	KES	KES48	1	1				54	54				100	0	0	0
19/10/2017	12:18	PC	4	SBZ	SBZ192	2			1		207			207		0	0	100	0
22/10/2017	07:43	PC	5	PAH	PAH87	1	1				50	50				100	0	0	0
22/10/2017	07:53	PC	5	PAH	PAH88	1	1				63	63				100	0	0	0
22/10/2017	08:08	PC	5	PAH	PAH89	1	1				58	58				100	0	0	0
22/10/2017	08:19	PC	5	KES	KES49	1		1			84	84				100	0	0	0
22/10/2017	08:44	PC	5	PAH	PAH90	1	1				76	76				100	0	0	0
22/10/2017	09:06	PC	5	PAH	PAH91	1	1				49	49				100	0	0	0
22/10/2017	09:17	PC	5	KES	KES50	1	1				80	55	25			69	31	0	0
22/10/2017	11:57	PC	6	STE	STE41	1			1		375			375		0	0	100	0
22/10/2017	12:15	PC	6	STE	STE42	1			1		281			281		0	0	100	0
22/10/2017	12:36	PC	6	KES	KES51	1		1			93			93		0	0	100	0

JACOBS ZATE

Date	Time	Observer	VP	KSA Code	Bout	No.	Height at point of detection				Durations (s)					Percentage time			
							<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	Total	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m	<30m	30-70m	S: 70-220m A: 70-275m	S: >225m A: >275m
23/10/2017	09:21	PC	7	MAH	MAH59	1	1				147	147				100	0	0	0
24/10/2017	07:02	PC	9	KES	KES52	1	1				34	34				100	0	0	0
24/10/2017	07:14	PC	9	KES	KES53	1	1				42	42				100	0	0	0
24/10/2017	09:09	PC	9	MAH	MAH60	1	1				63	63				100	0	0	0

Appendix E. All Figures





SA217900-DMT-G-PLN-GE06

Legend

Site Boundary

Indicative Turbine Layout

Rev	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AG	AD	MR

JACOBS ZATE

Client

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

SITE LAYOUT

Drawing Status

Scale @ A3	1:80,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-GE06	

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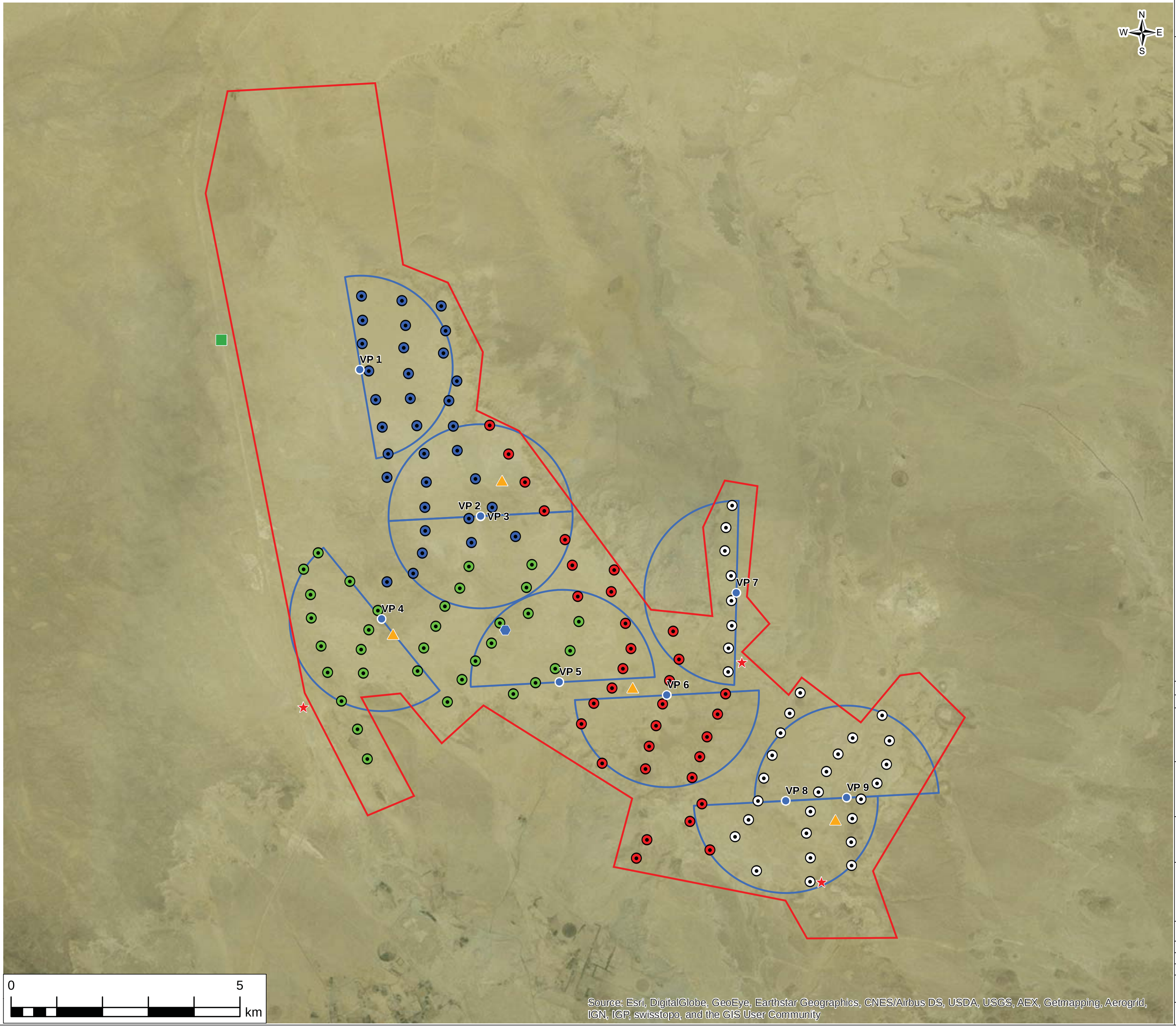
SA217900-DMT-G-PLN-TB09



Legend

- Site Boundary
- Viewpoint Arc
- Access Point
- Communication Tower
- Met Mast
- Resident farmer

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052
- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076
- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

0	JAN 17	Initial Issue	IM	AD	AD	MR
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

JACOBS ZATE

Client

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Project

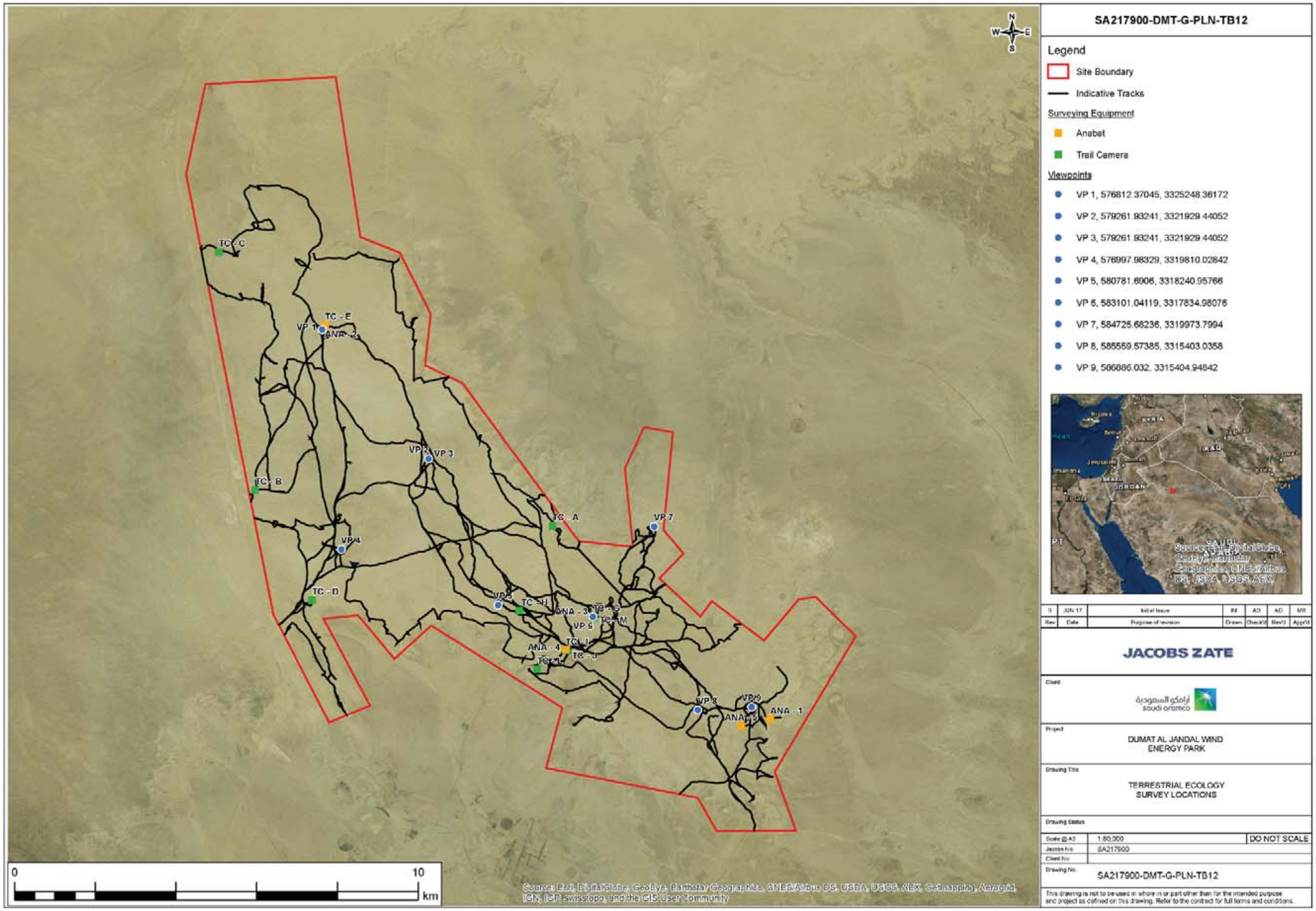
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

MIGRATORY BIRD VANTAGE POINT SURVEY LOCATIONS

Drawing Status

Scale @ A3	1:80,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB09	


SA217900-DMT-G-PLN-TB12
Legend
Site Boundary
Indicative Tracks
Surveying Equipment
Anabat
Trail Camera
Viewpoints
VP 1, 576812.37045, 3325248.36172
VP 2, 579261.93241, 3321929.44052
VP 3, 579261.93241, 3321929.44052
VP 4, 576997.98329, 3319810.02842
VP 5, 580781.6906, 3318240.95766
VP 6, 583101.04119, 3317834.98076
VP 7, 584725.68236, 3319973.7994
VP 8, 585559.57385, 3315403.0358
VP 9, 586886.032, 3315404.94842
TC - C
TC - E
VP 1
ANA - 2
VP 2
VP 3
TC - B
TC - A
VP 7
VP 4
TC - D
TC - H
ANA - 3
VP 6
TC - M
ANA - 4
TC - I
VP 8
VP 9
ANA - 1
0
10
km
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
JORDAN
0 | JUN 17 | Initial Issue
Rev | Date | Purpose of revision | Drawn | Check'd | Rev'd | Appr'd
JACOBS ZATE
Client
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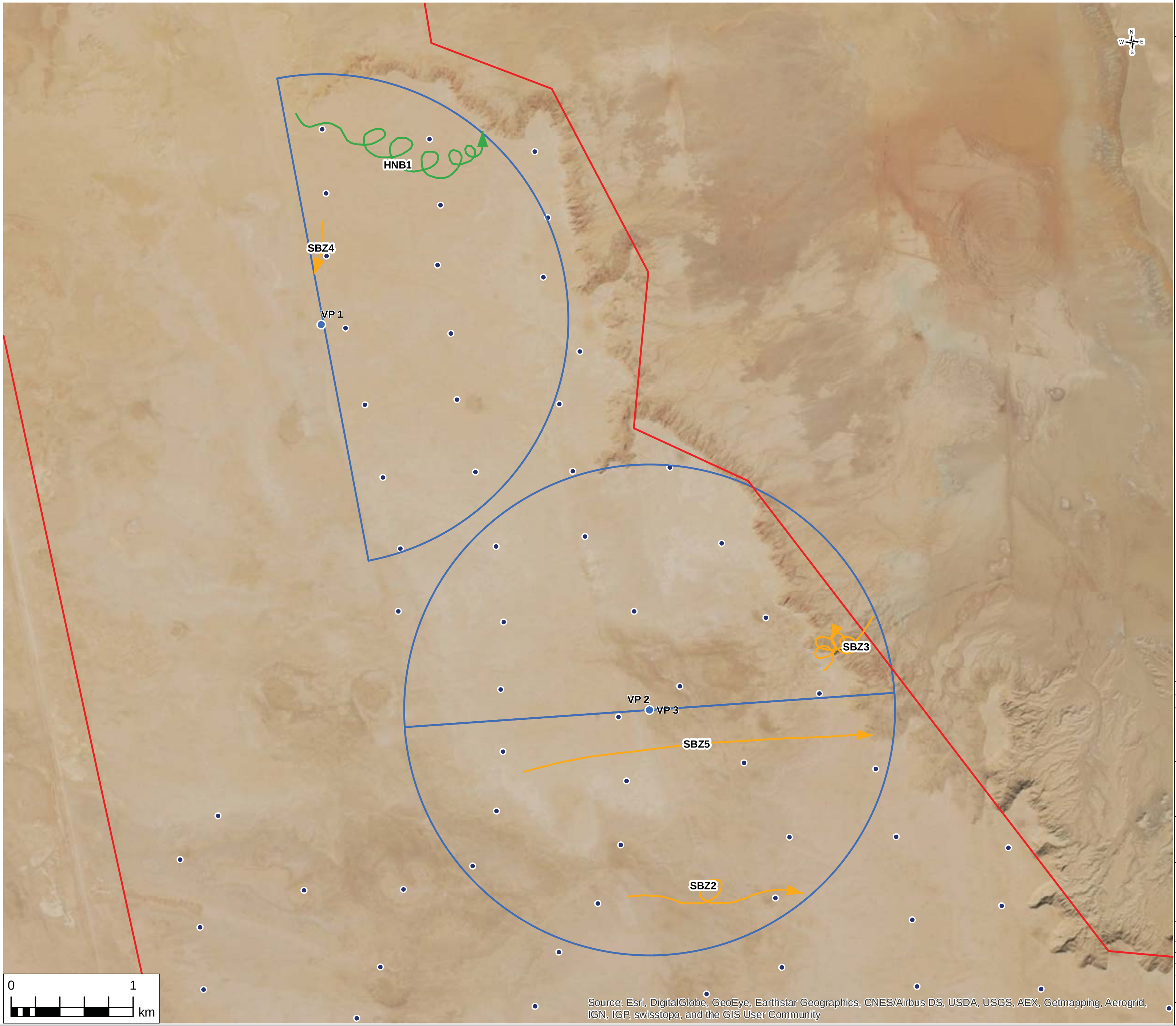
Project
DUMAT AL JANDAL WIND ENERGY PARK
Drawing Title
TERRESTRIAL ECOLOGY SURVEY LOCATIONS
Drawing Status
Scale @ A3 1:80,000
DO NOT SCALE
Jacobs No. SA217900
Client No.
Drawing No. SA217900-DMT-G-PLN-TB12
This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.



SA217900-DMT-G-PLN-TB18-01

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Honey Buzzard
- Steppe Buzzard

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

BUZZARD SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
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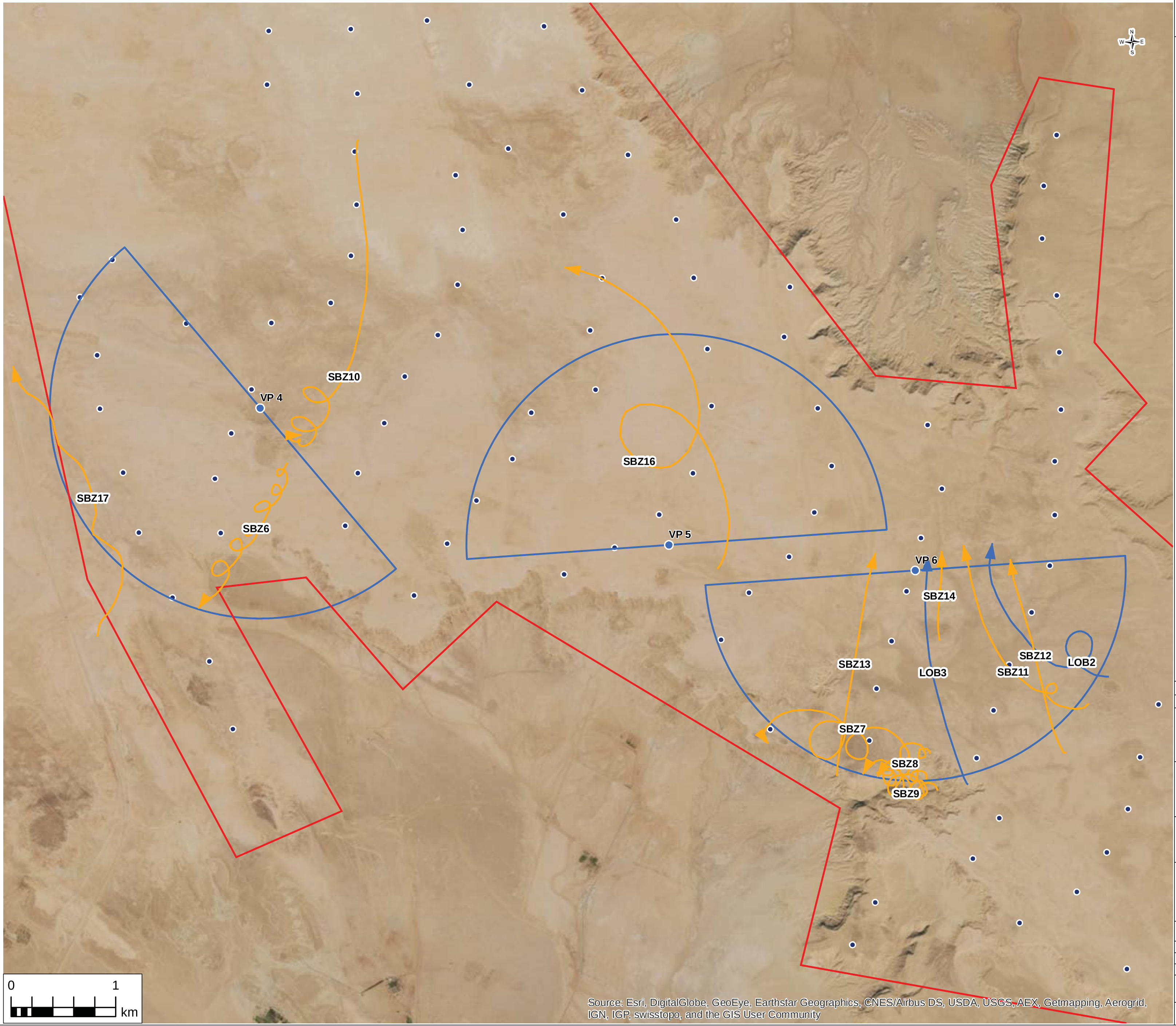
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-01	

SA217900-DMT-G-PLN-TB18-02



Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Long-legged Buzzard
- Steppe Buzzard

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

JACOBS ZATE

Client

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

BUZZARD SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
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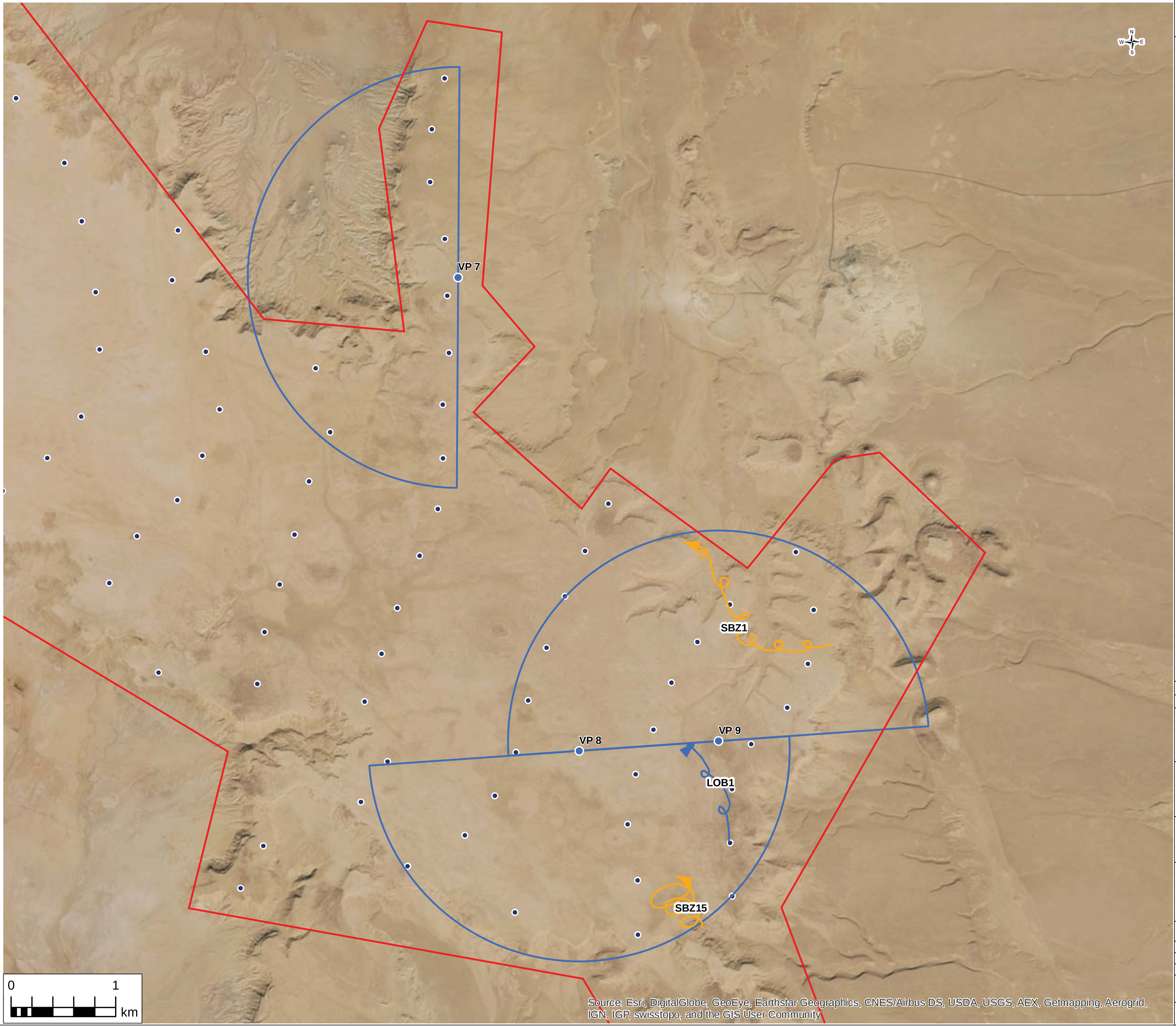
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-02	



SA217900-DMT-G-PLN-TB18-03

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Long-legged Buzzard
- Steppe Buzzard

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

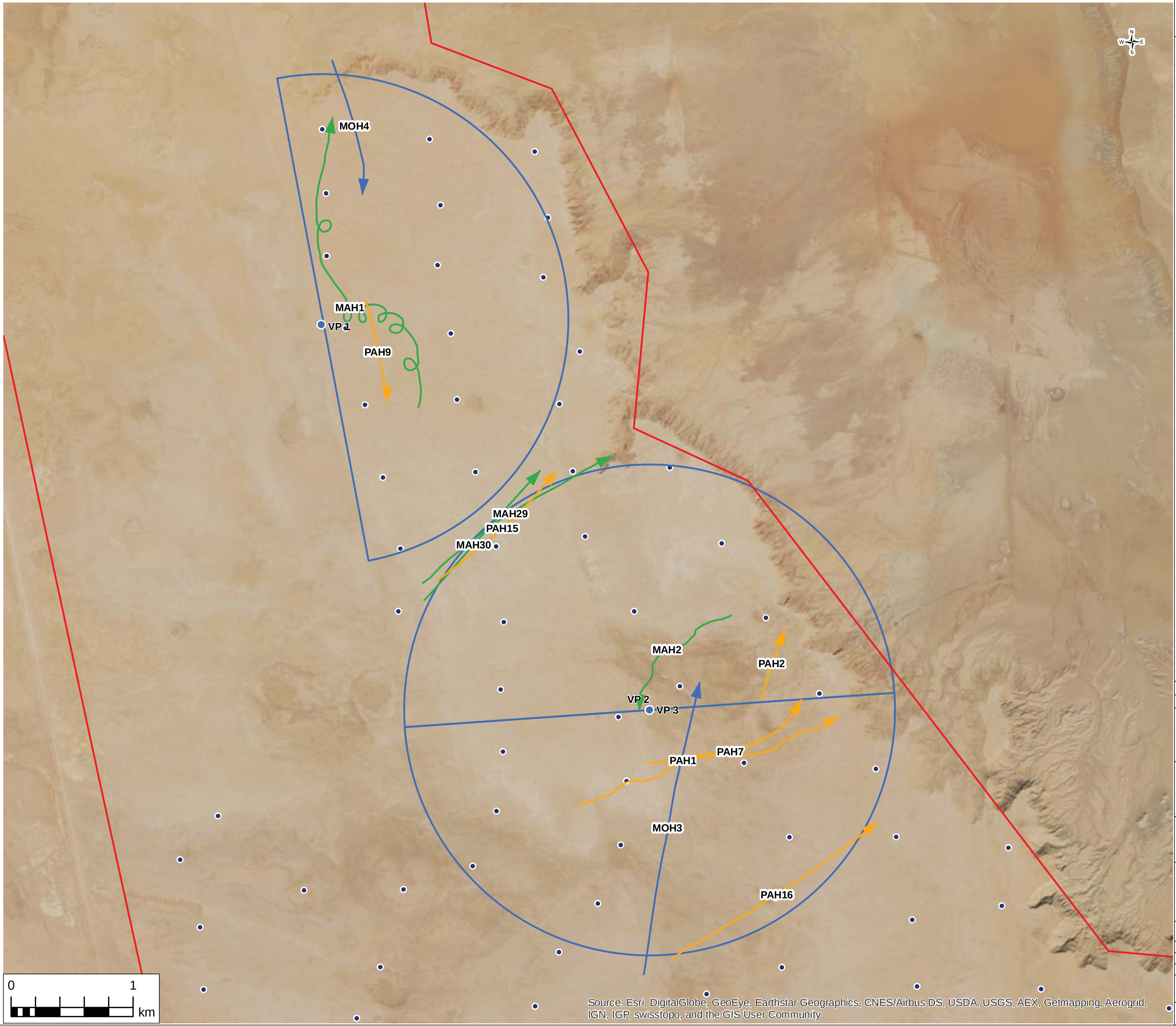
BUZZARD SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-03	

This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.

SA217900-DMT-G-PLN-TB18-04



Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Pallid Harrier
- Montagu's Harrier
- Marsh Harrier

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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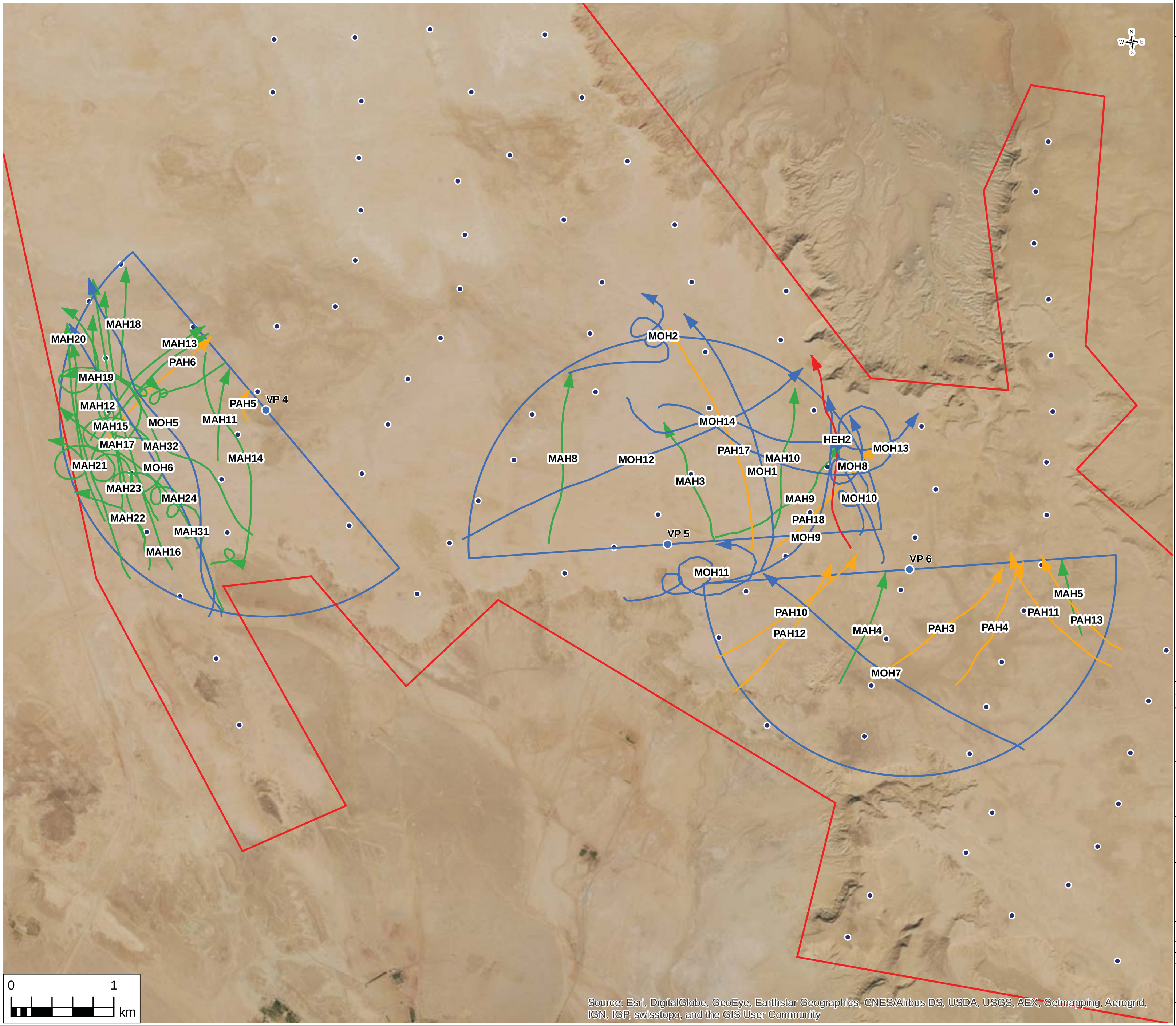
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

HARRIER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-04	



SA217900-DMT-G-PLN-TB18-05

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Pallid Harrier
- Montagu's Harrier
- Marsh Harrier
- Hen Harrier

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

HARRIER SPECIES FLIGHT LINES

Drawing Status

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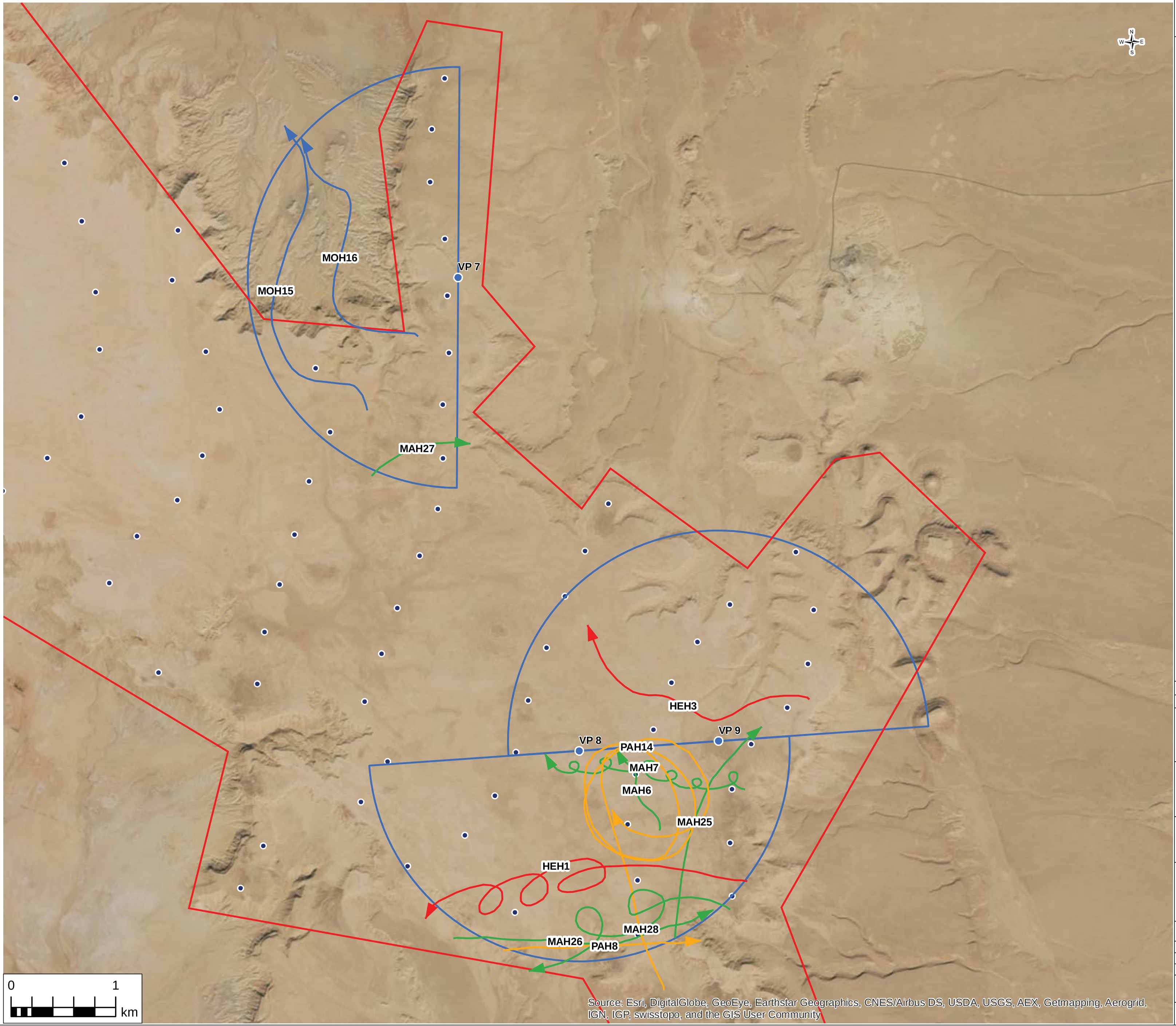

SA217900-DMT-G-PLN-TB18-06

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Pallid Harrier
- Montagu's Harrier
- Marsh Harrier
- Hen Harrier

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

HARRIER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
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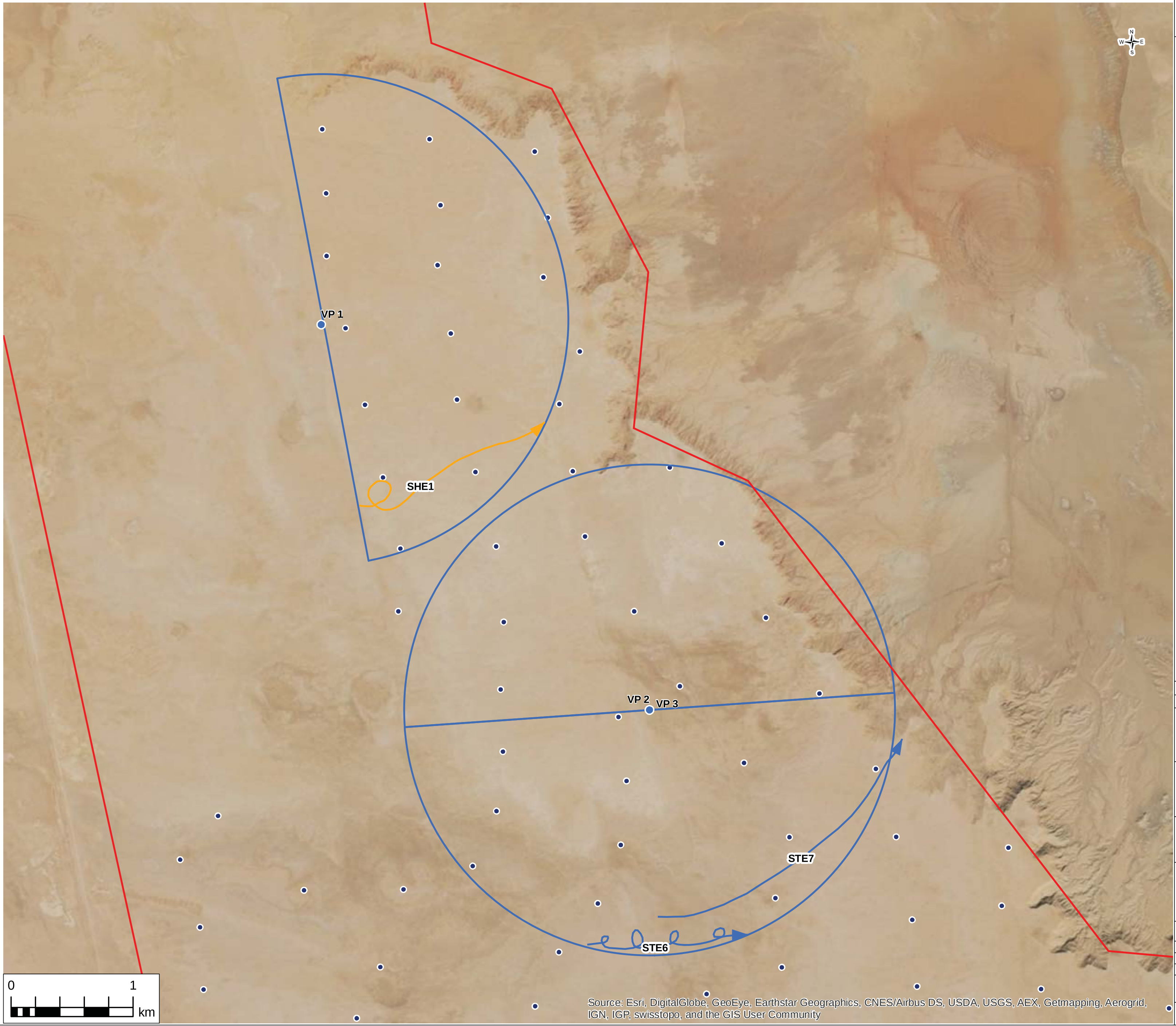

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Short-toed Snake Eagle
- Steppe Eagle

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

EAGLE SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
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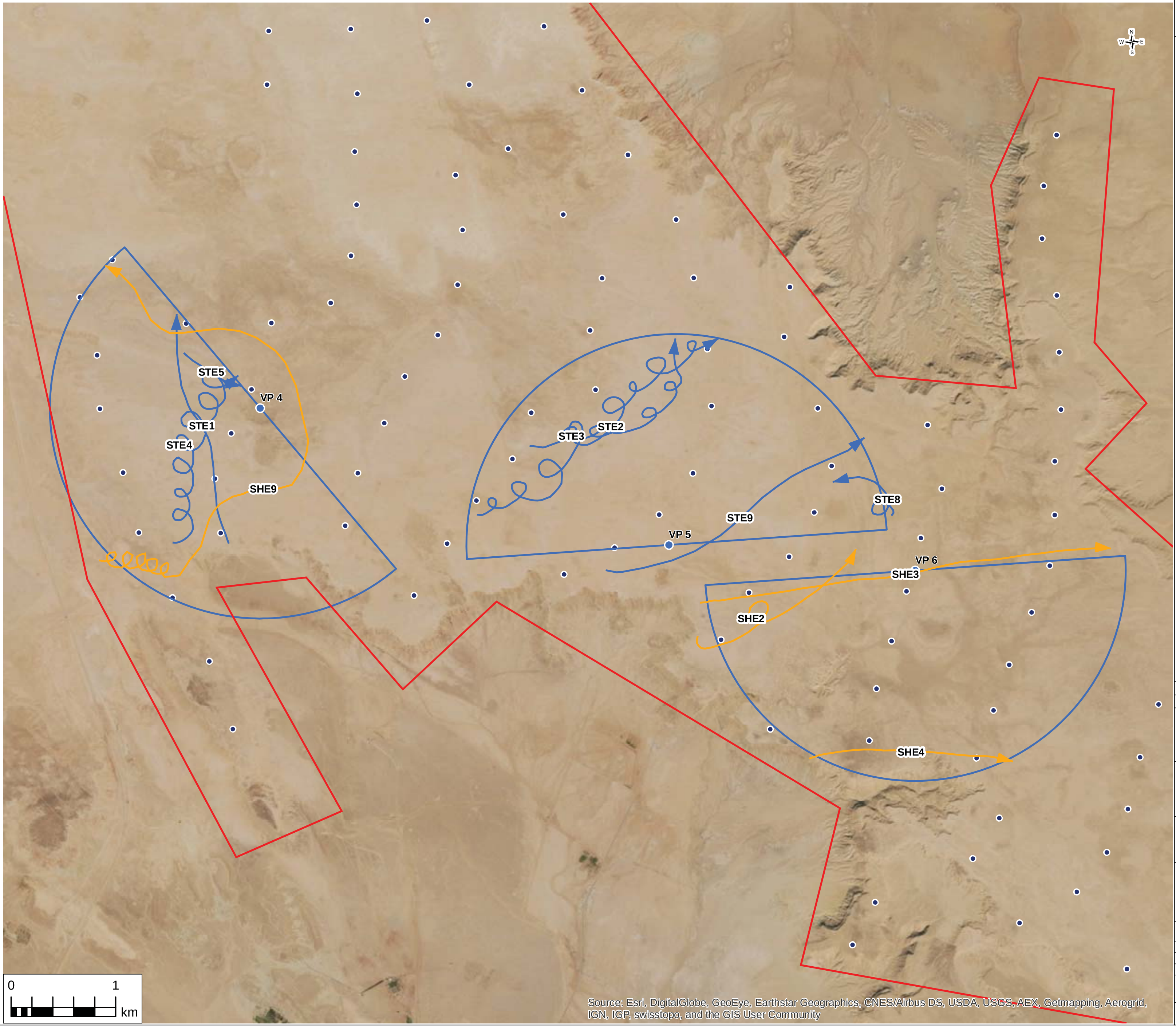
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-07	



SA217900-DMT-G-PLN-TB18-08

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Short-toed Snake Eagle
- Steppe Eagle

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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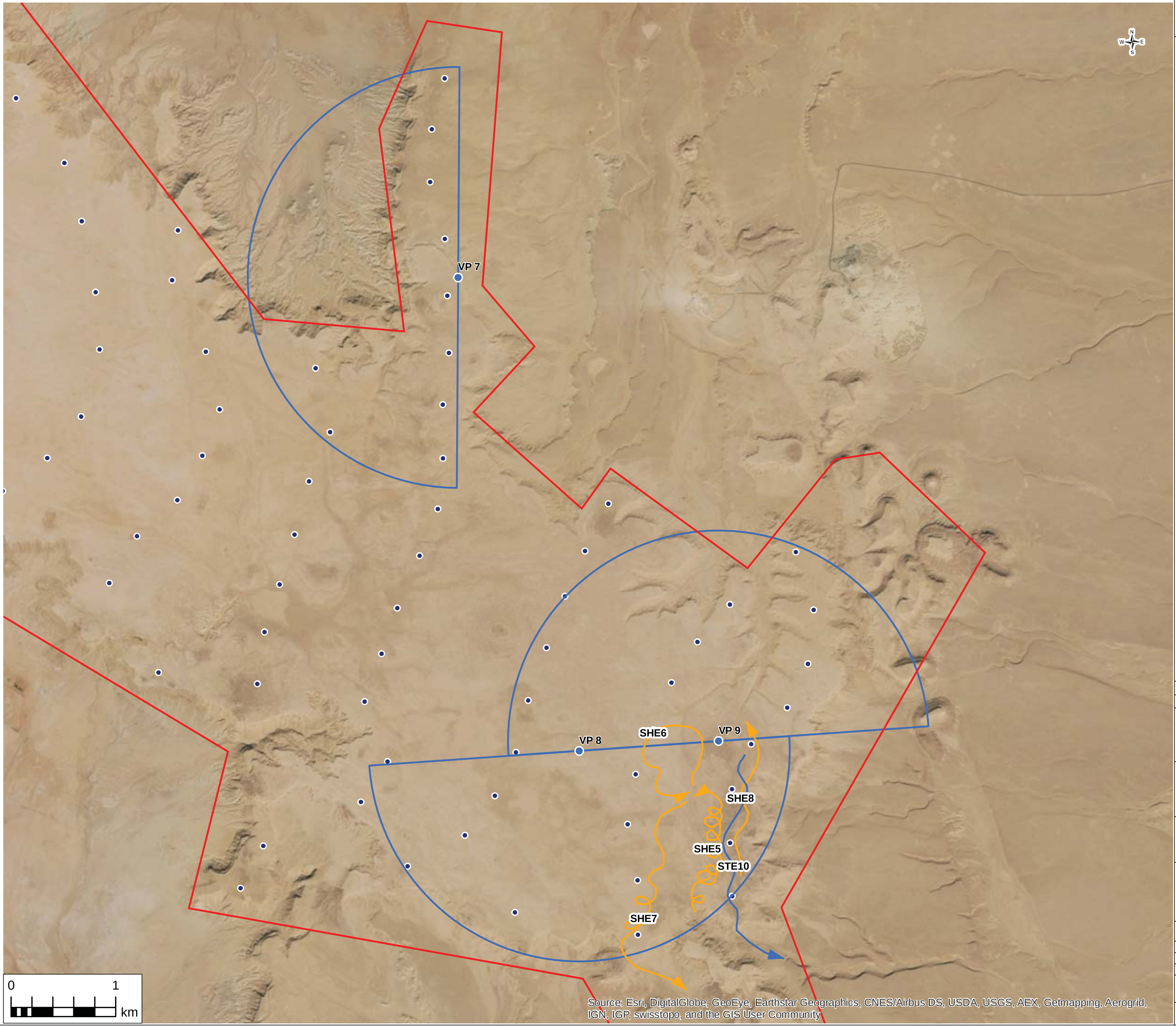
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

EAGLE SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-08	



SA217900-DMT-G-PLN-TB18-09

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Short-toed Snake Eagle
- Steppe Eagle

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

EAGLE SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
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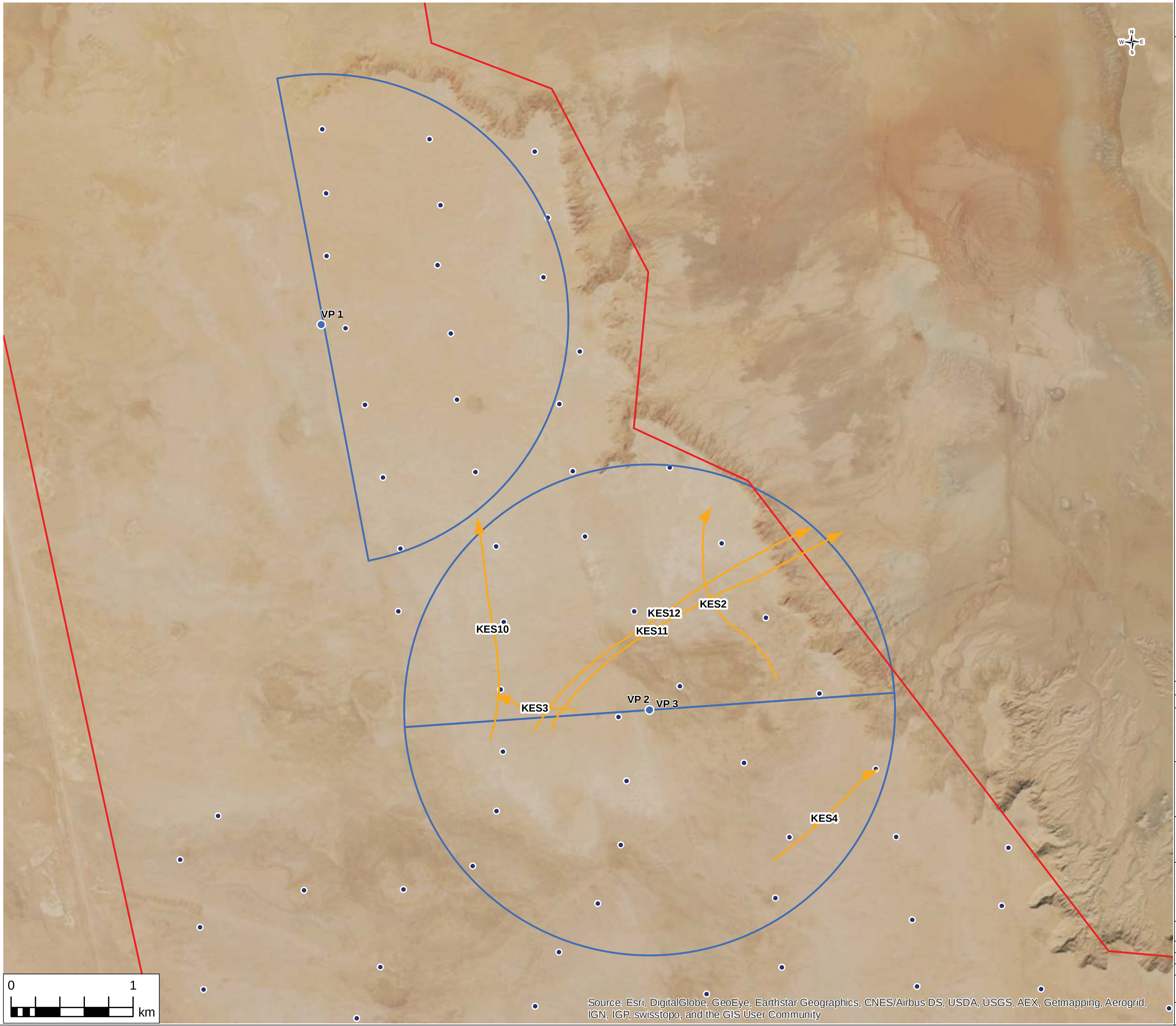
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-09	

SA217900-DMT-G-PLN-TB18-10



Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Kestrel

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

FALCON SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-10	

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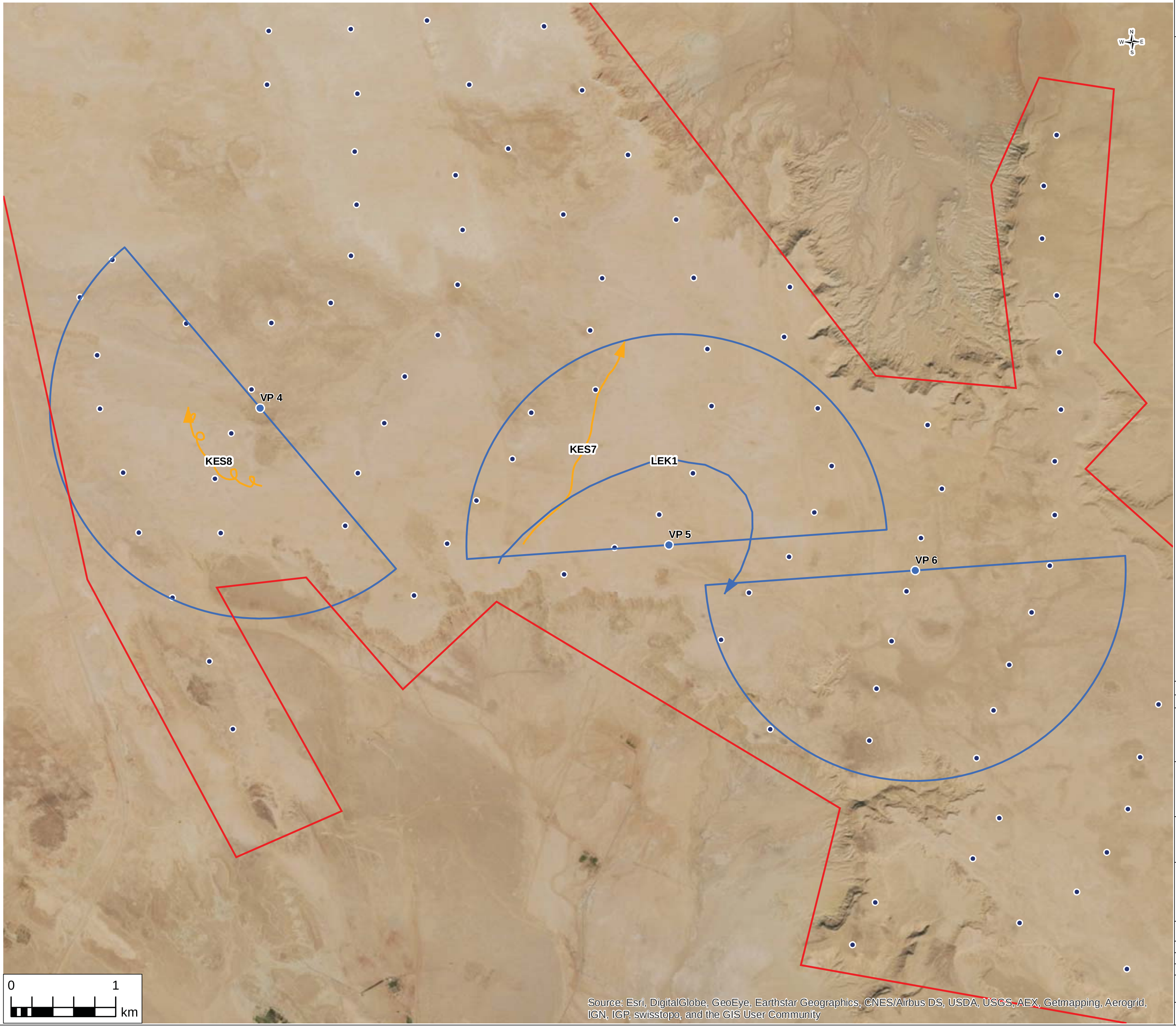
SA217900-DMT-G-PLN-TB18-11



Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Kestrel
- Lesser Kestrel

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

JACOBS ZATE

Client

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

FALCON SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
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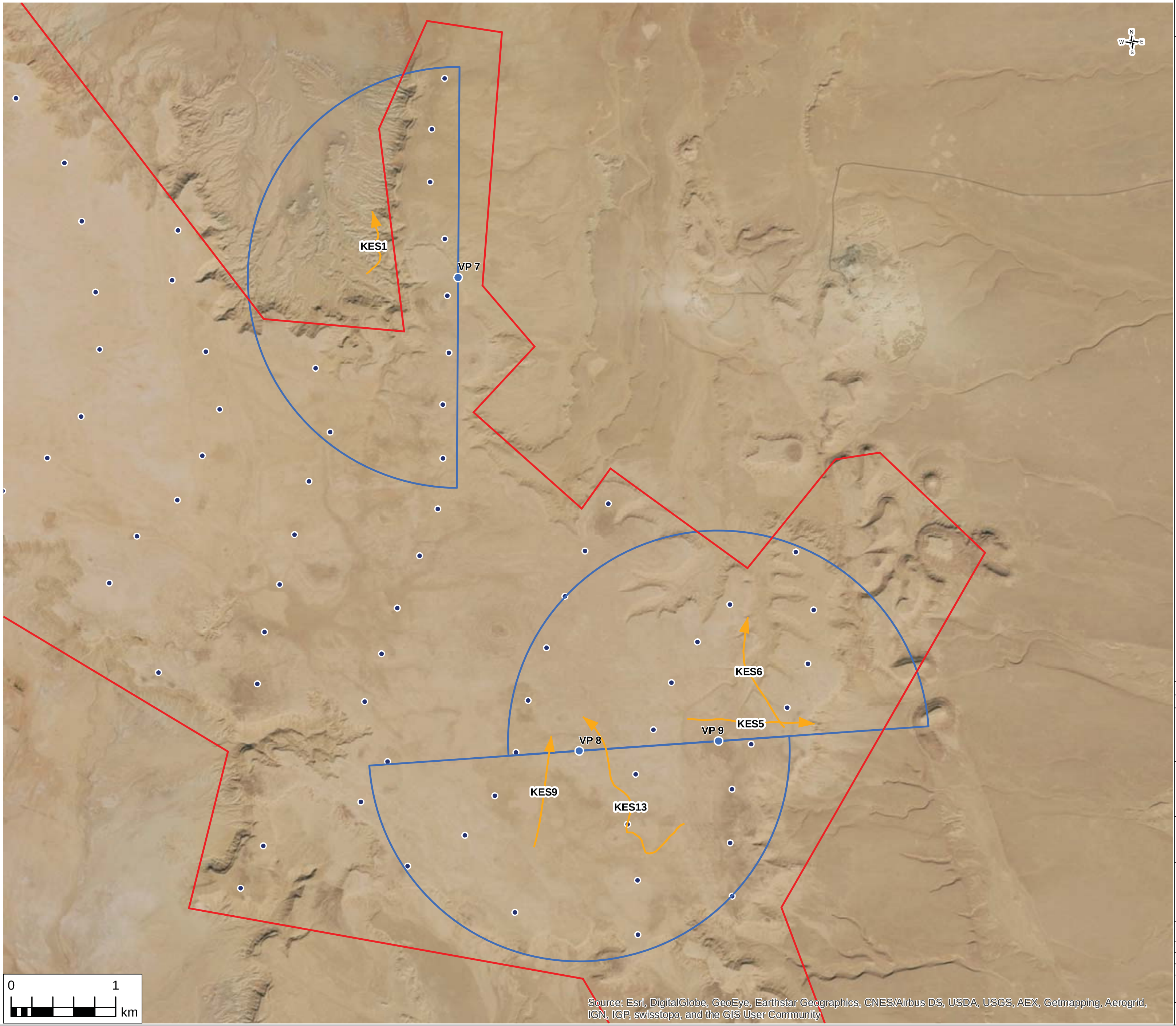
Drawing No.	SA217900-DMT-G-PLN-TB18-11	

SA217900-DMT-G-PLN-TB18-12



Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Kestrel

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

JACOBS ZATE

Client

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

FALCON SPECIES FLIGHT LINES

Drawing Status

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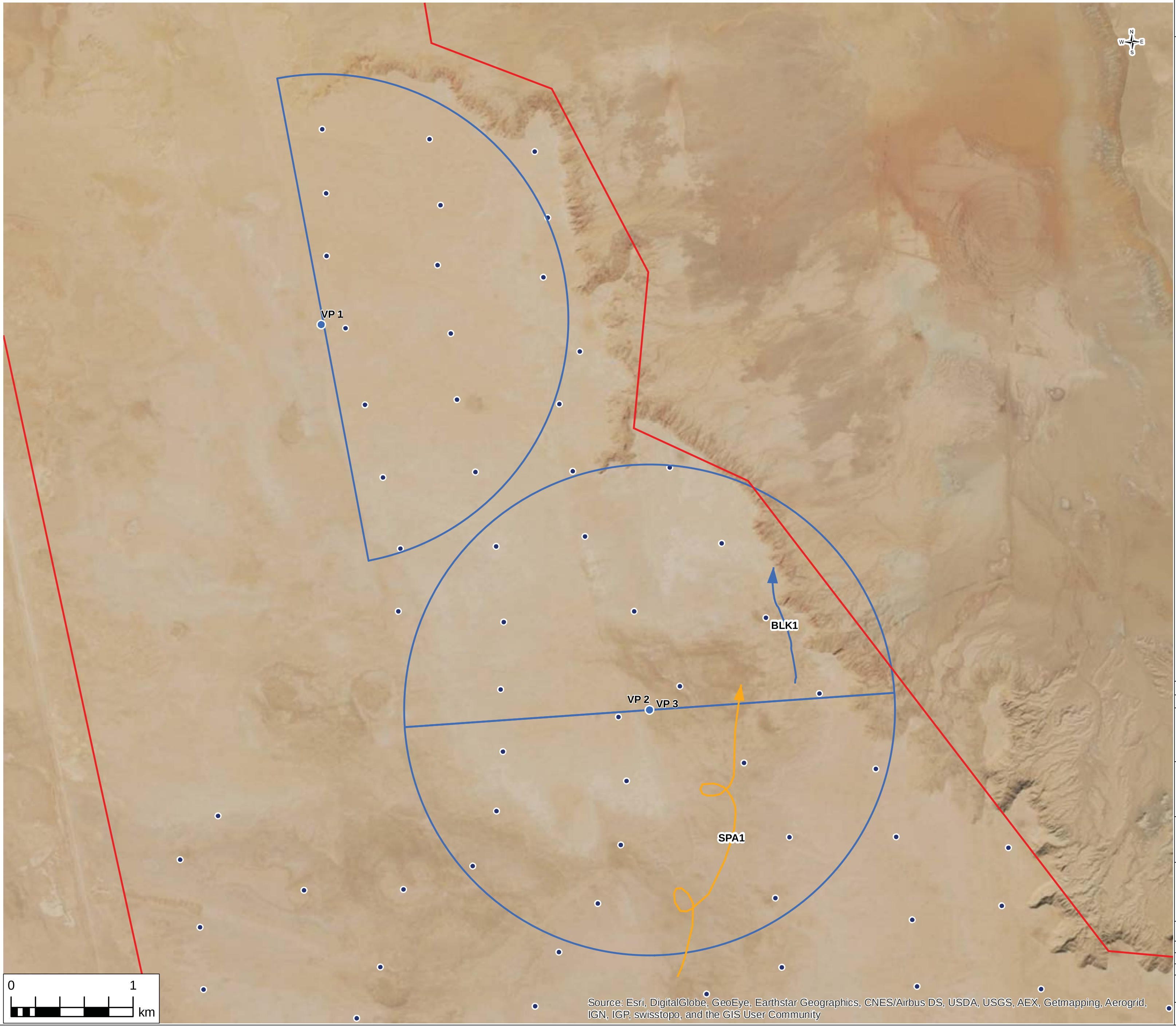
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-12	



SA217900-DMT-G-PLN-TB18-13

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Sparrowhawk
- Black Kite

0	JUN 17	Initial Issue	IM	AD	AD	MR
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

JACOBS ZATE

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Project

DUMAT AL JANDAL WIND ENERGY PARK

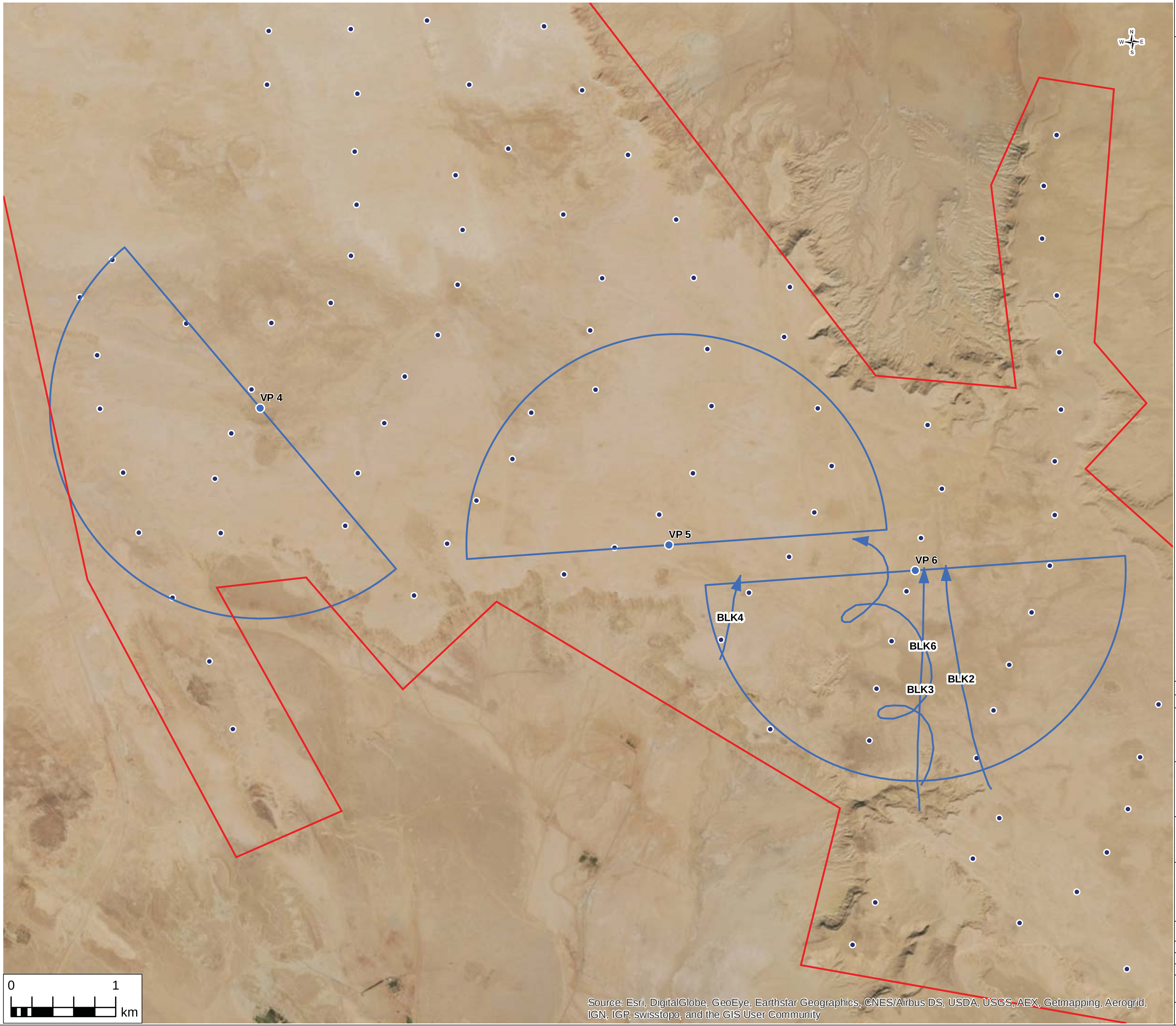
Drawing Title

OTHER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-13	

This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.



SA217900-DMT-G-PLN-TB18-14

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Black Kite

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

JACOBS ZATE

Client

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Project

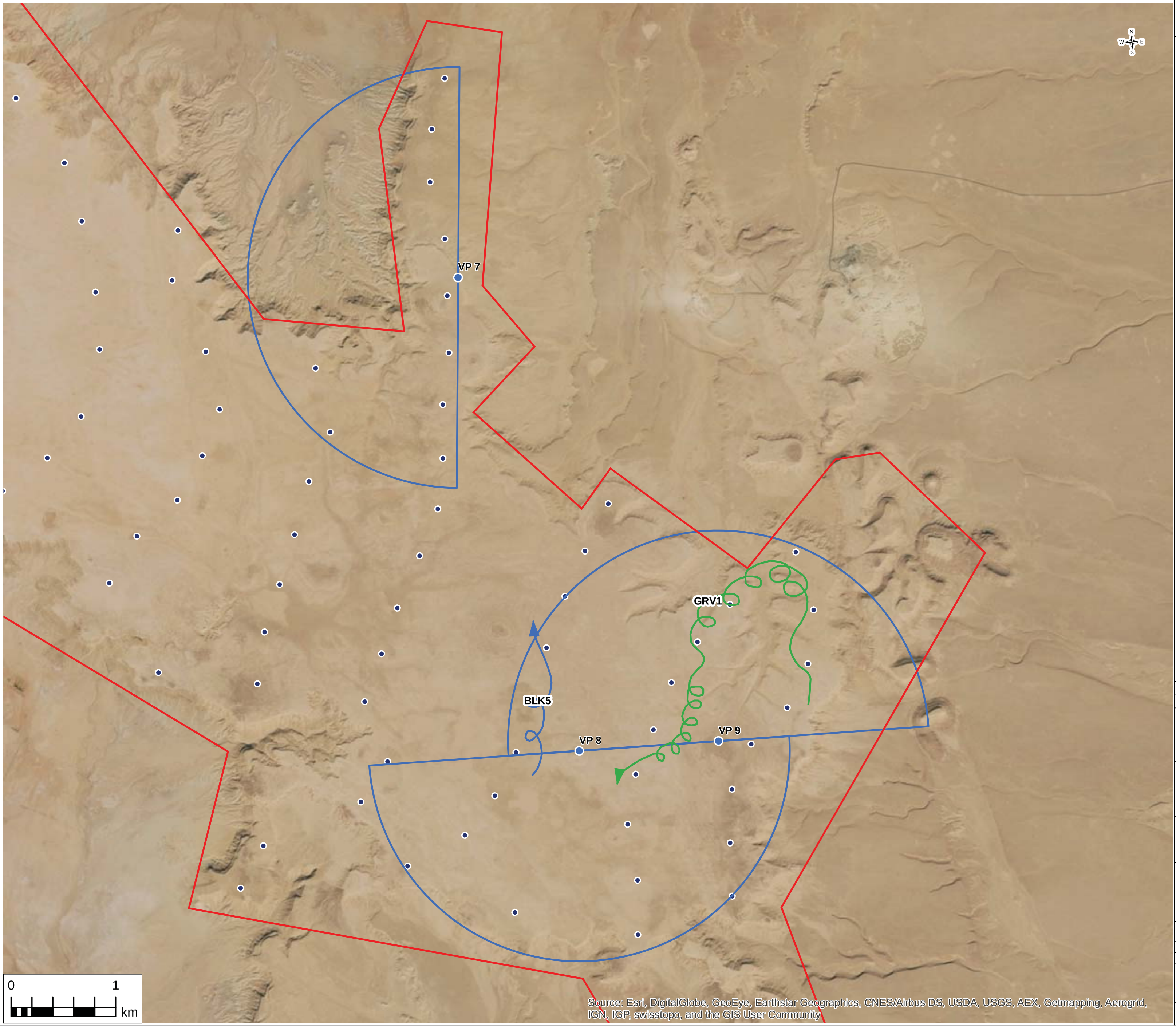
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

OTHER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-14	



SA217900-DMT-G-PLN-TB18-15

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Black Kite
- Griffon Vulture

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Project

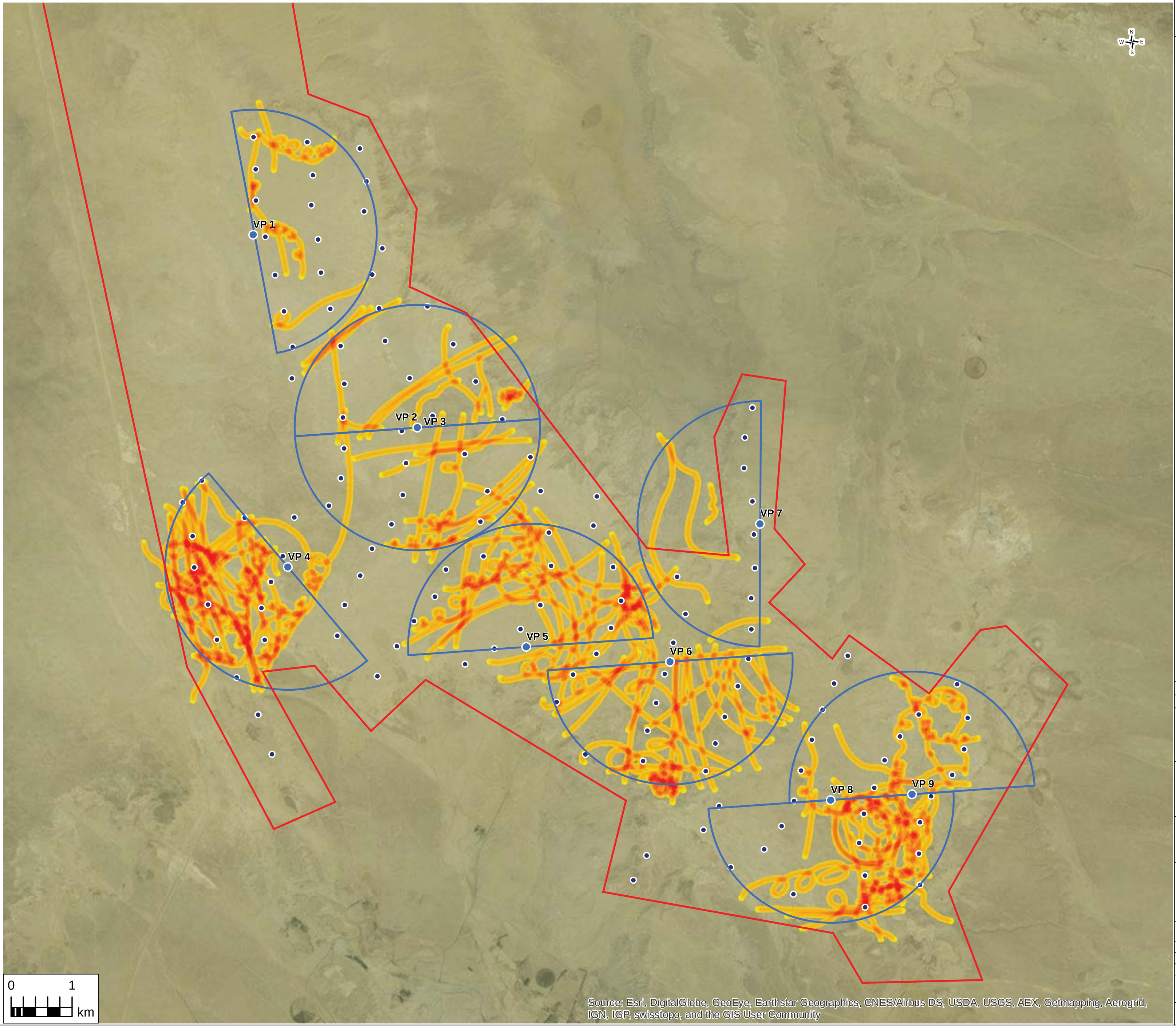
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

OTHER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-15	



SA217900-DMT-G-PLN-TB18-16

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052
- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076
- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Relative Density of Flight Lines

Higher

Lower

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

ALL SPECIES FLIGHT LINES SPRING SURVEYS

Drawing Status

Scale @ A3	1:60,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-16	

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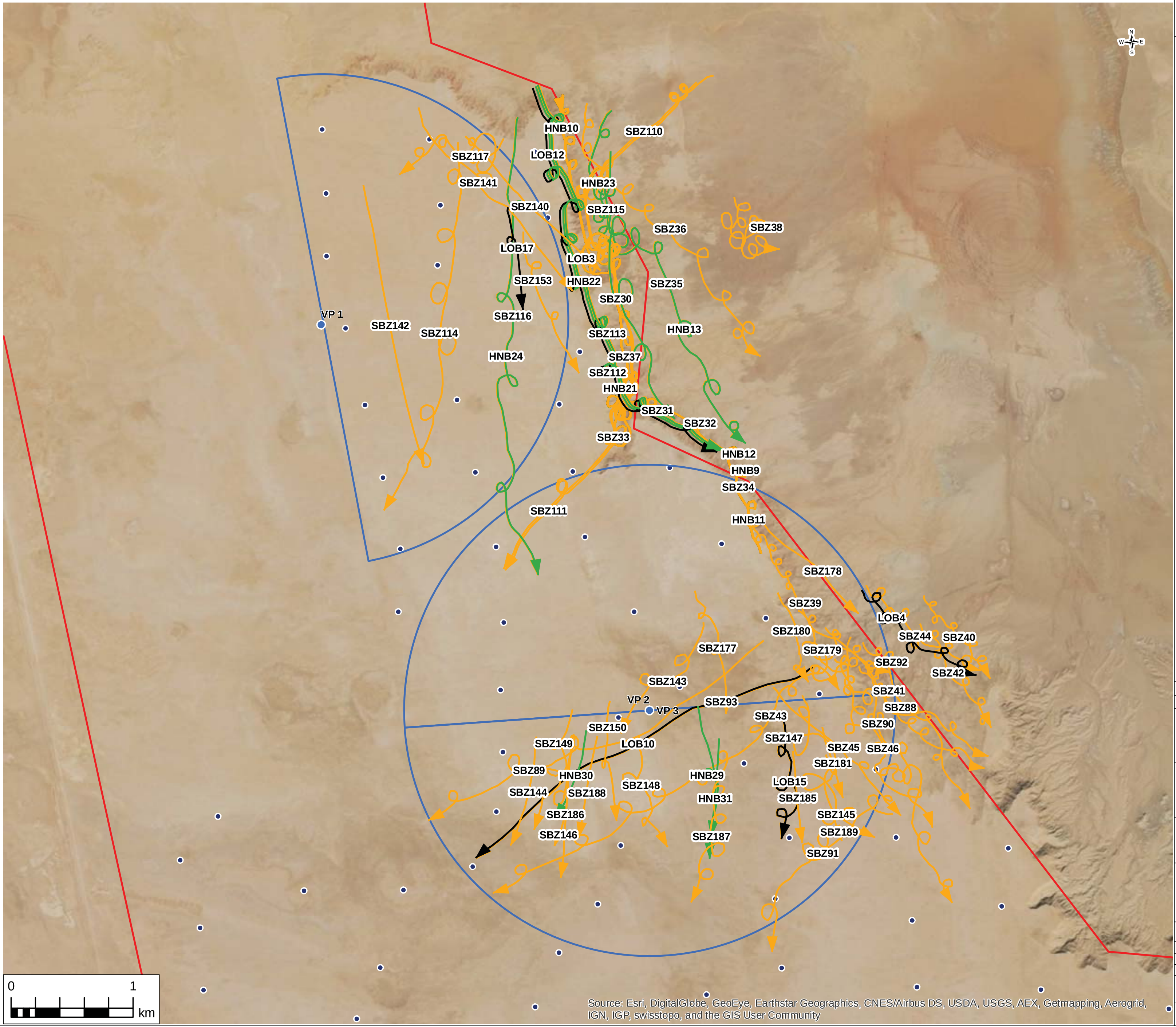
SA217900-DMT-G-PLN-TB19-01



Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- European honey buzzard
- Long-legged buzzard
- Steppe buzzard

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

BUZZARD SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
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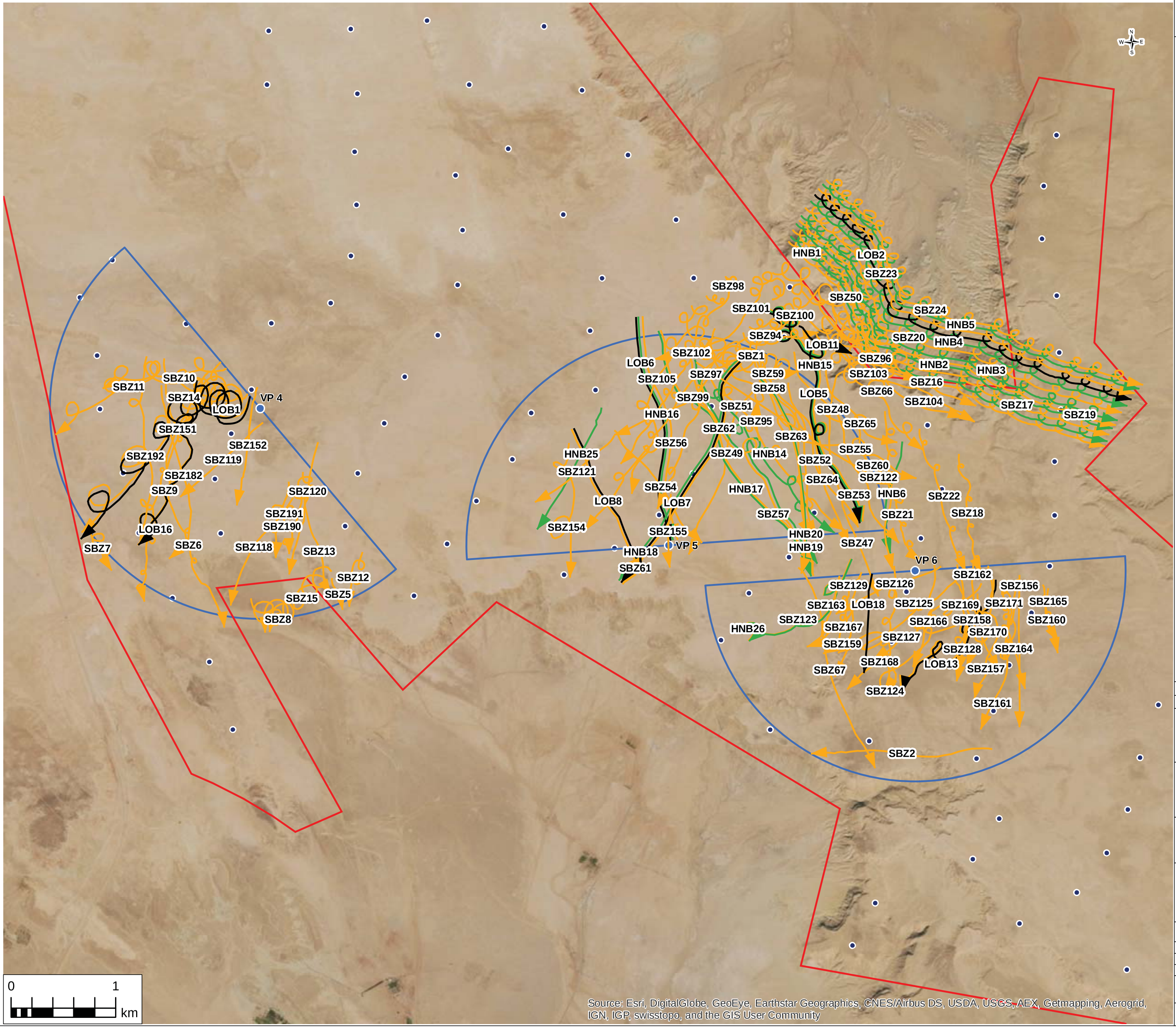
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-01	

SA217900-DMT-G-PLN-TB19-02



Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- European honey buzzard
- Long-legged buzzard
- Steppe buzzard

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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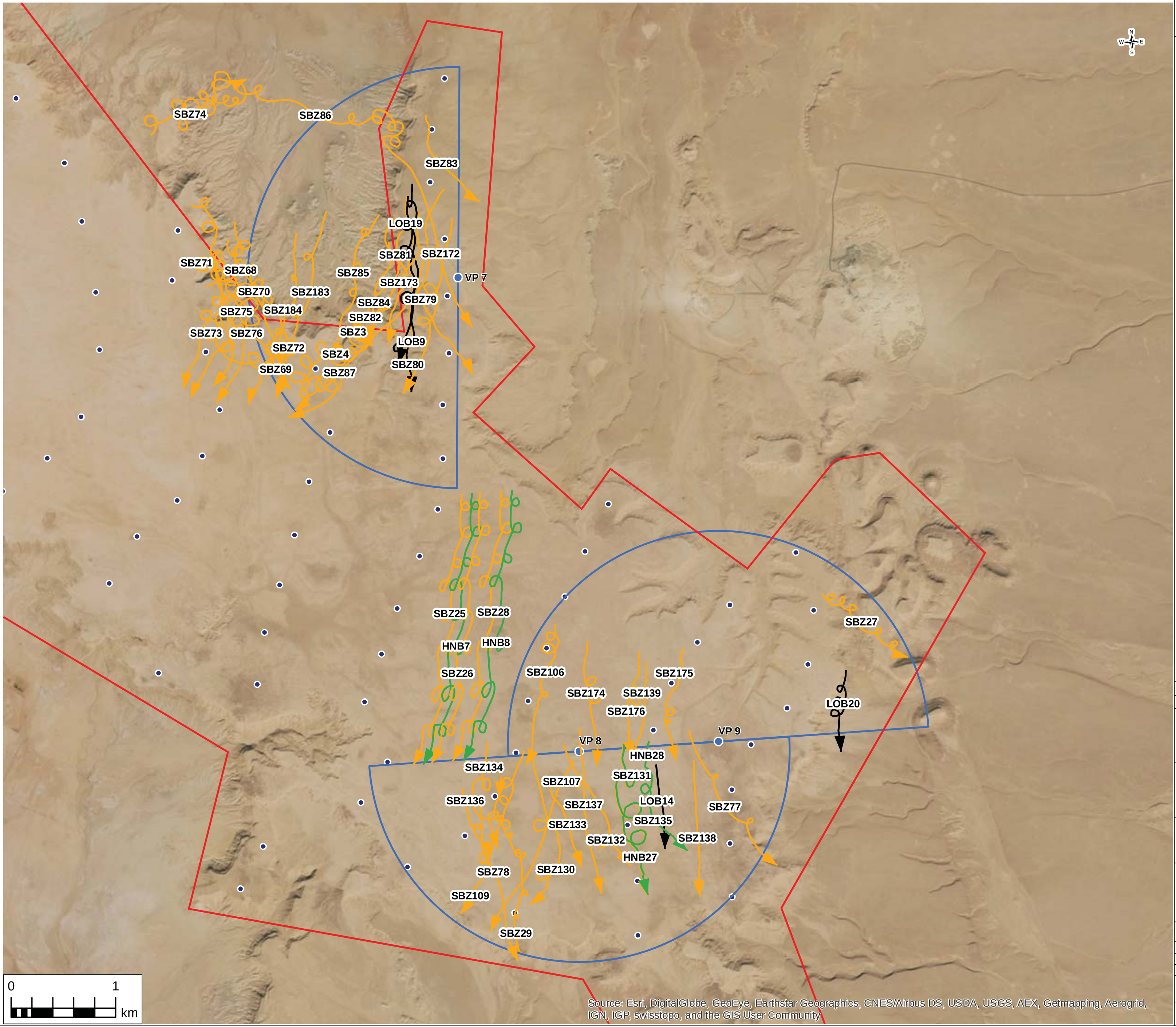
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

BUZZARD SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-02	



SA217900-DMT-G-PLN-TB19-03

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- European honey buzzard
- Long-legged buzzard
- Steppe buzzard

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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Project

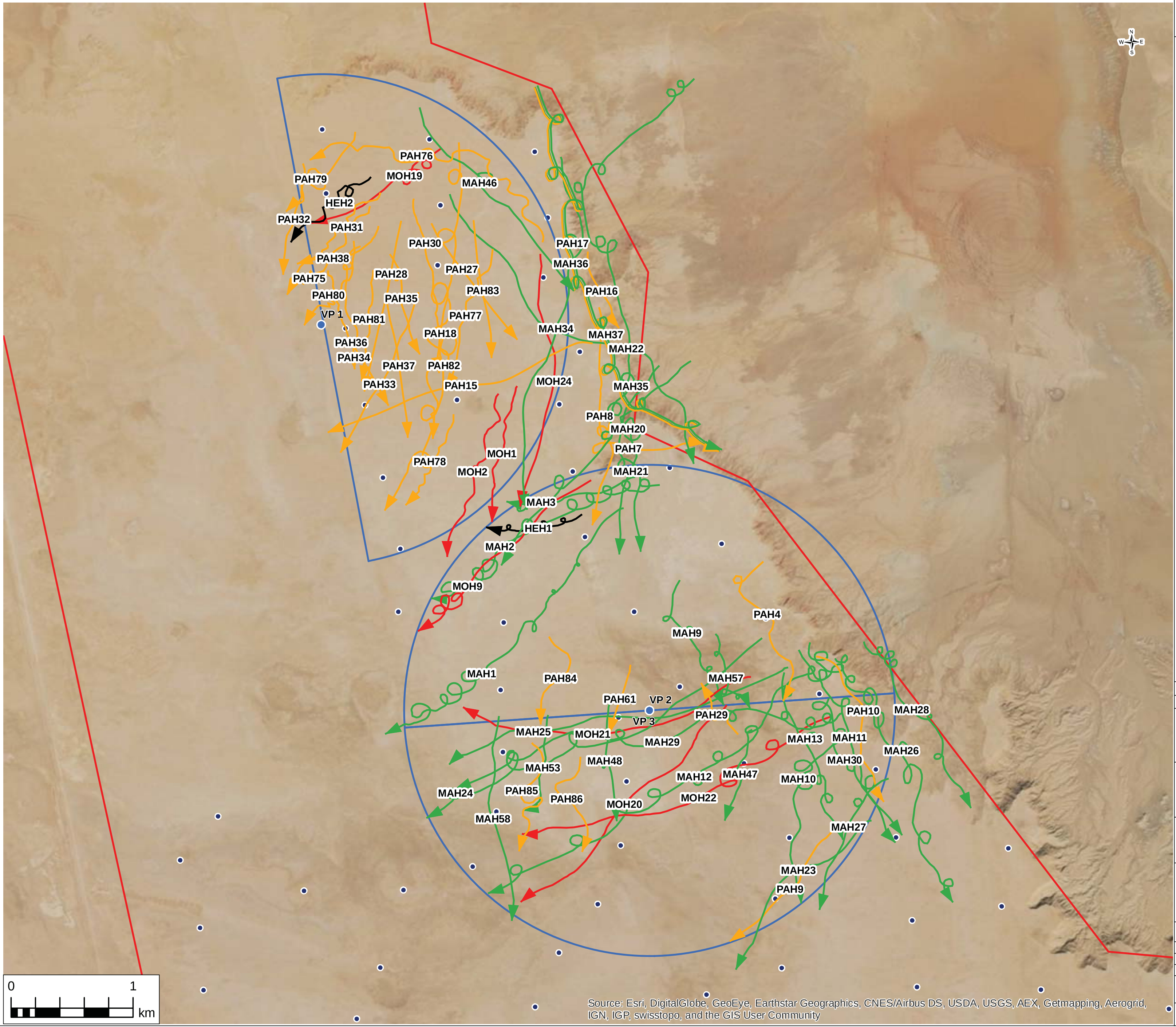
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

BUZZARD SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-03	



SA217900-DMT-G-PLN-TB19-04

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Hen harrier
- Pallid harrier
- Montagu's harrier
- Marsh harrier

0	NOV 17	Initial Issue	IM	AD	AD	MR
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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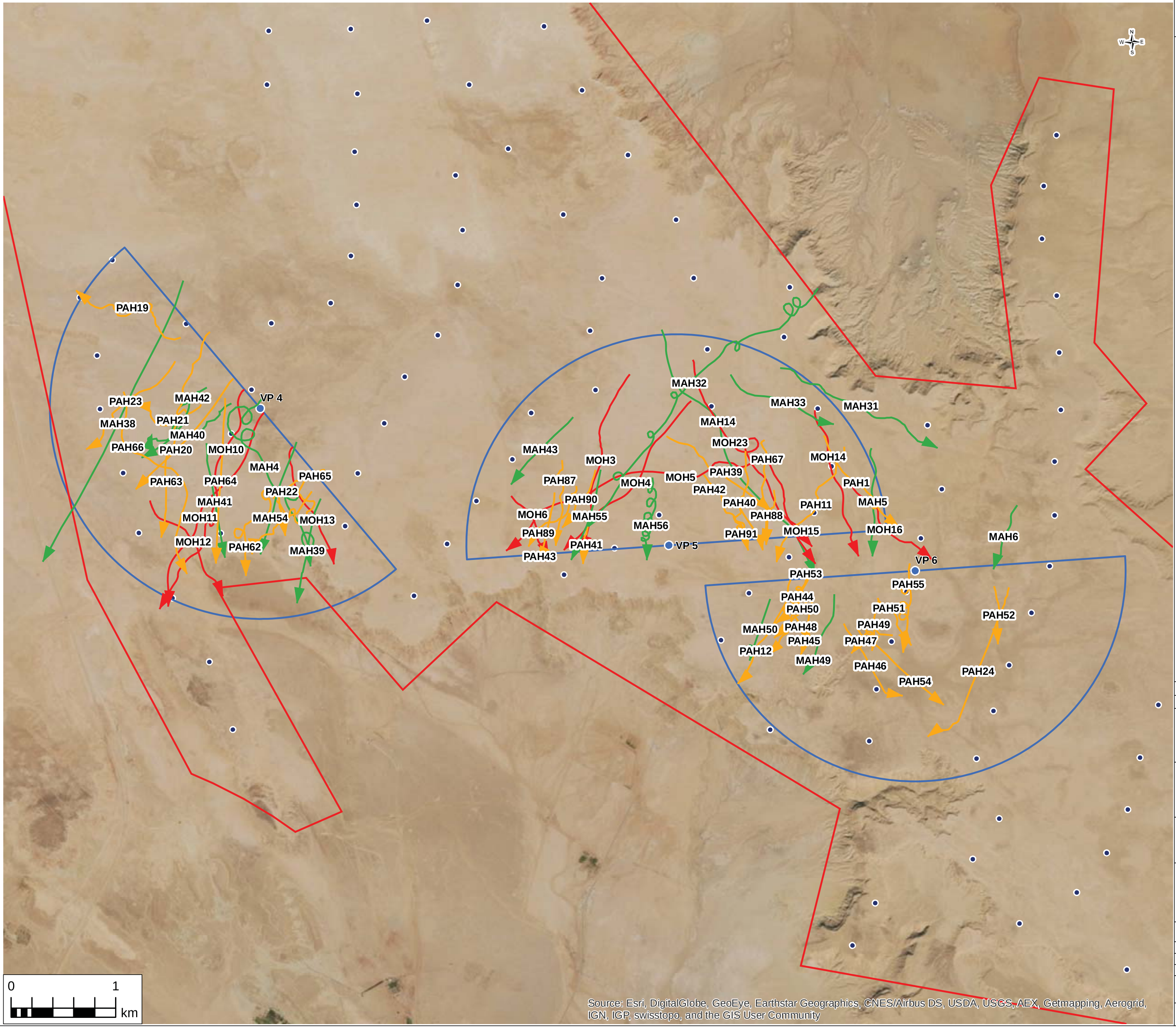
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

HARRIER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-04	



SA217900-DMT-G-PLN-TB19-05

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Pallid harrier
- Montagu's harrier
- Marsh harrier

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

HARRIER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-05	

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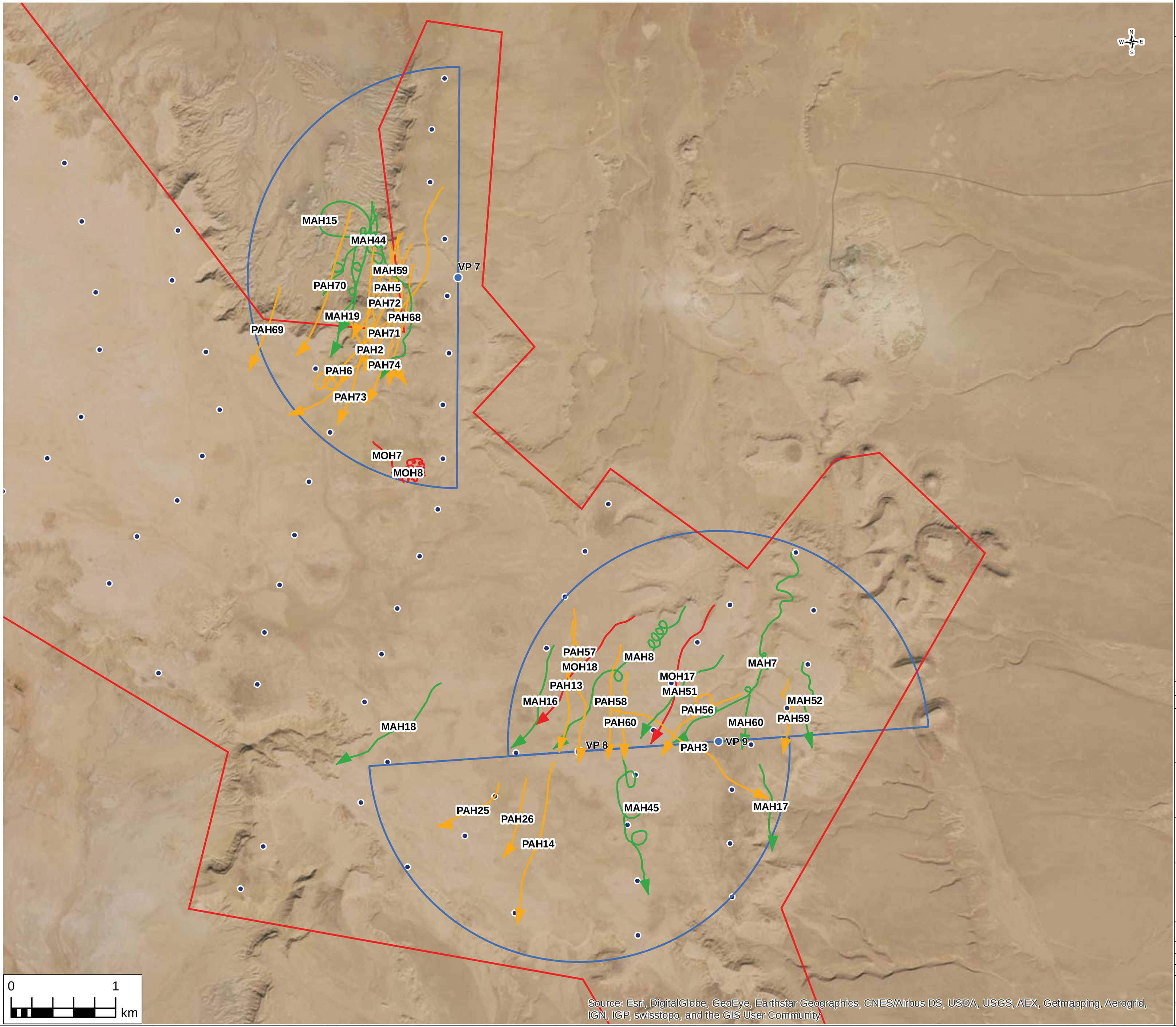

SA217900-DMT-G-PLN-TB19-06

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Pallid harrier
- Montagu's harrier
- Marsh harrier

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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DUMAT AL JANDAL WIND ENERGY PARK

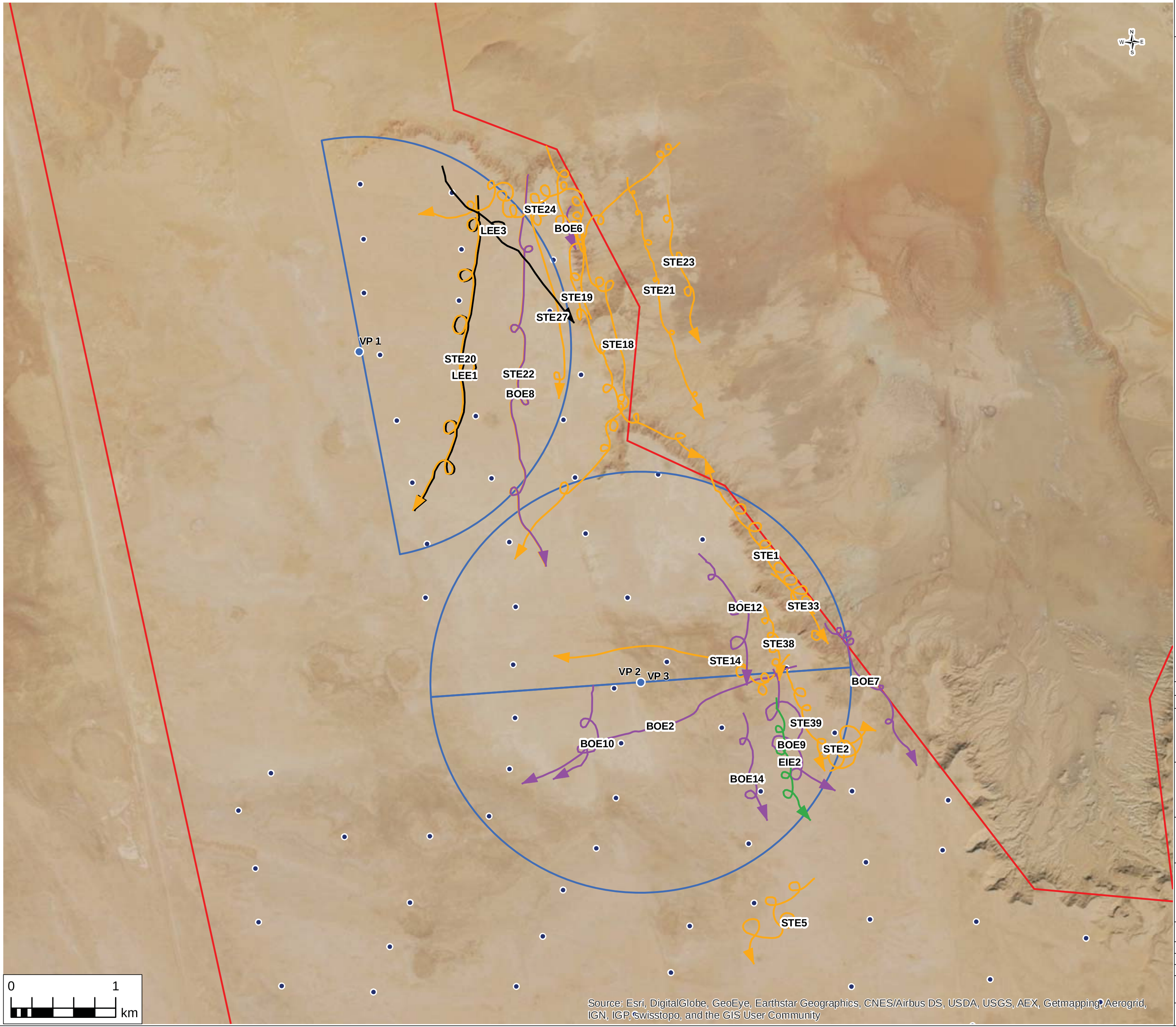
Drawing Title

HARRIER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-06	

SA217900-DMT-G-PLN-TB19-07



Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Booted eagle
- Eastern imperial eagle
- Lesser-spotted eagle
- Steppe eagle

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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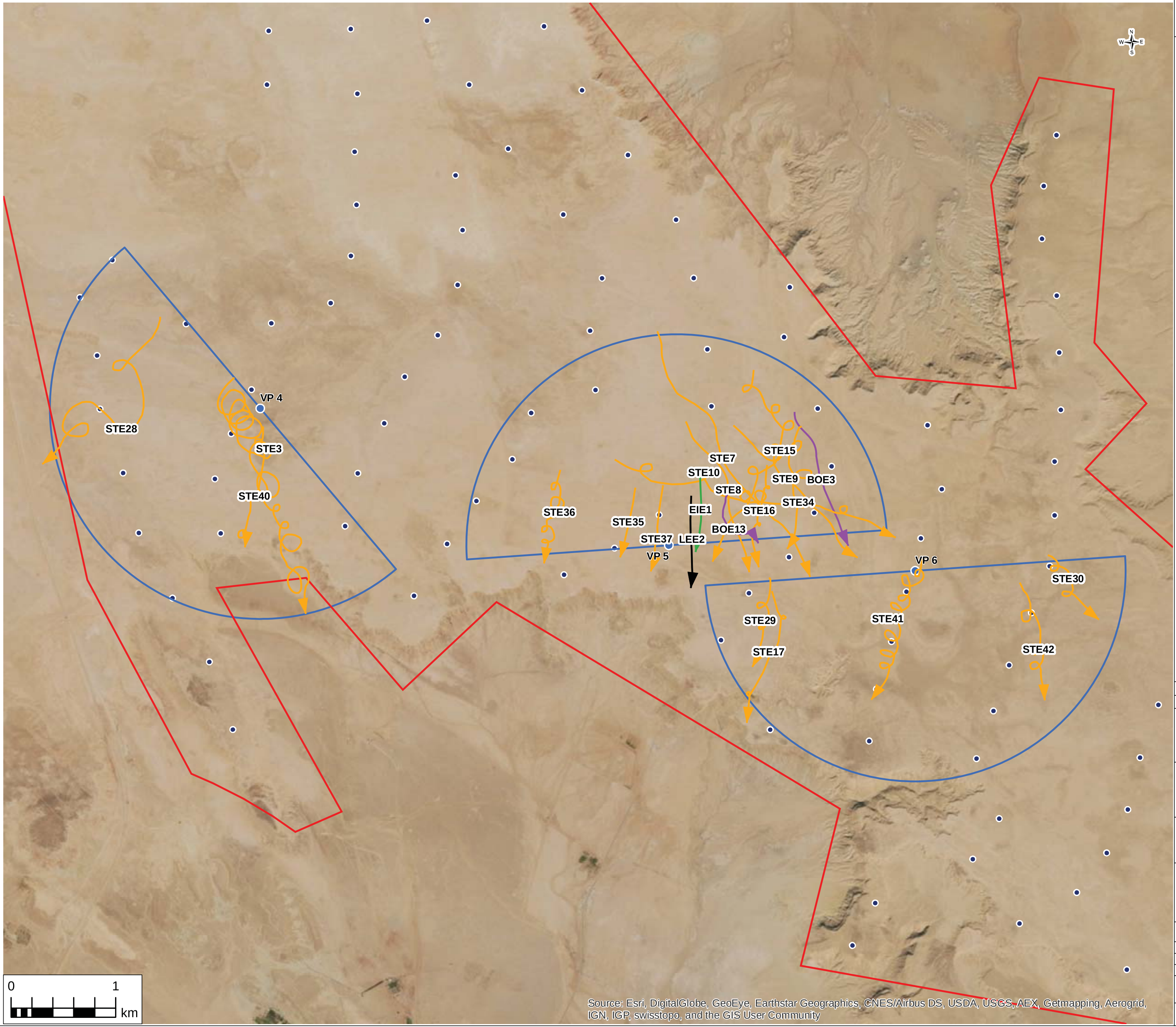
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

EAGLE SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-07	



SA217900-DMT-G-PLN-TB19-08

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Booted eagle
- Eastern imperial eagle
- Lesser-spotted eagle
- Steppe eagle

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

EAGLE SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-08	

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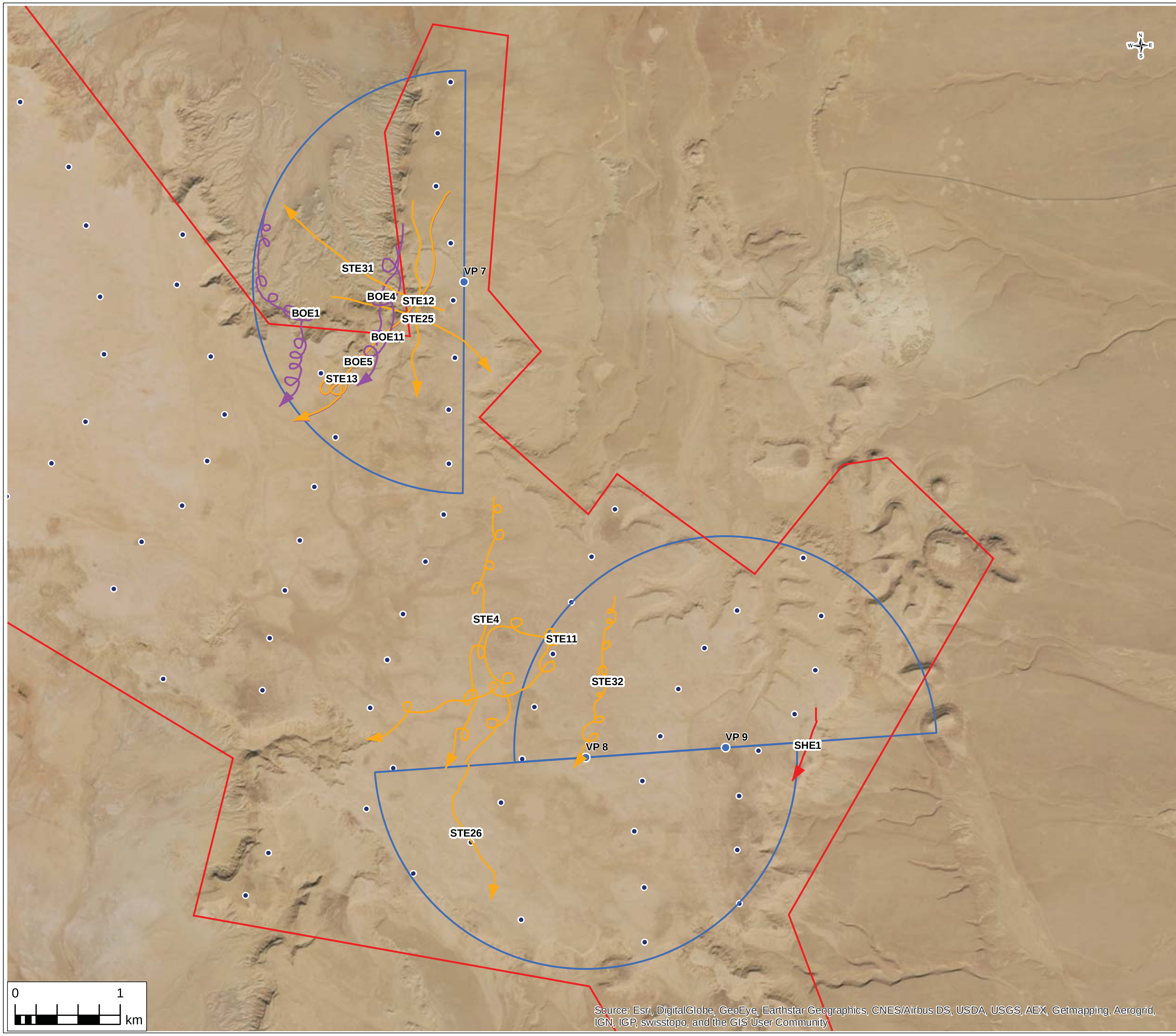
SA217900-DMT-G-PLN-TB19-09



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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Project

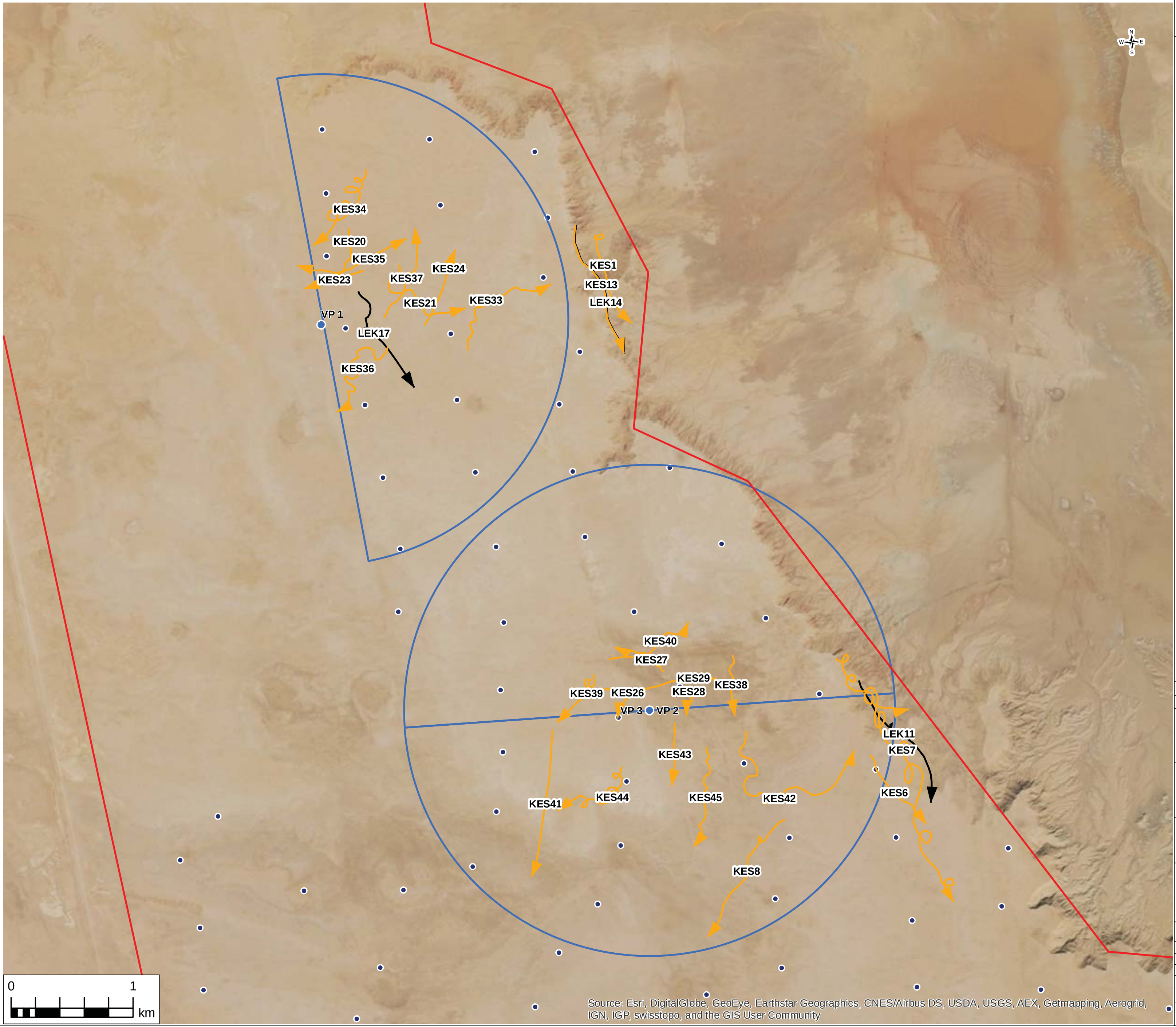
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

EAGLE SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-09	



SA217900-DMT-G-PLN-TB19-10

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Kestrel
- Lesser kestrel

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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Client

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saudi aramco

Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

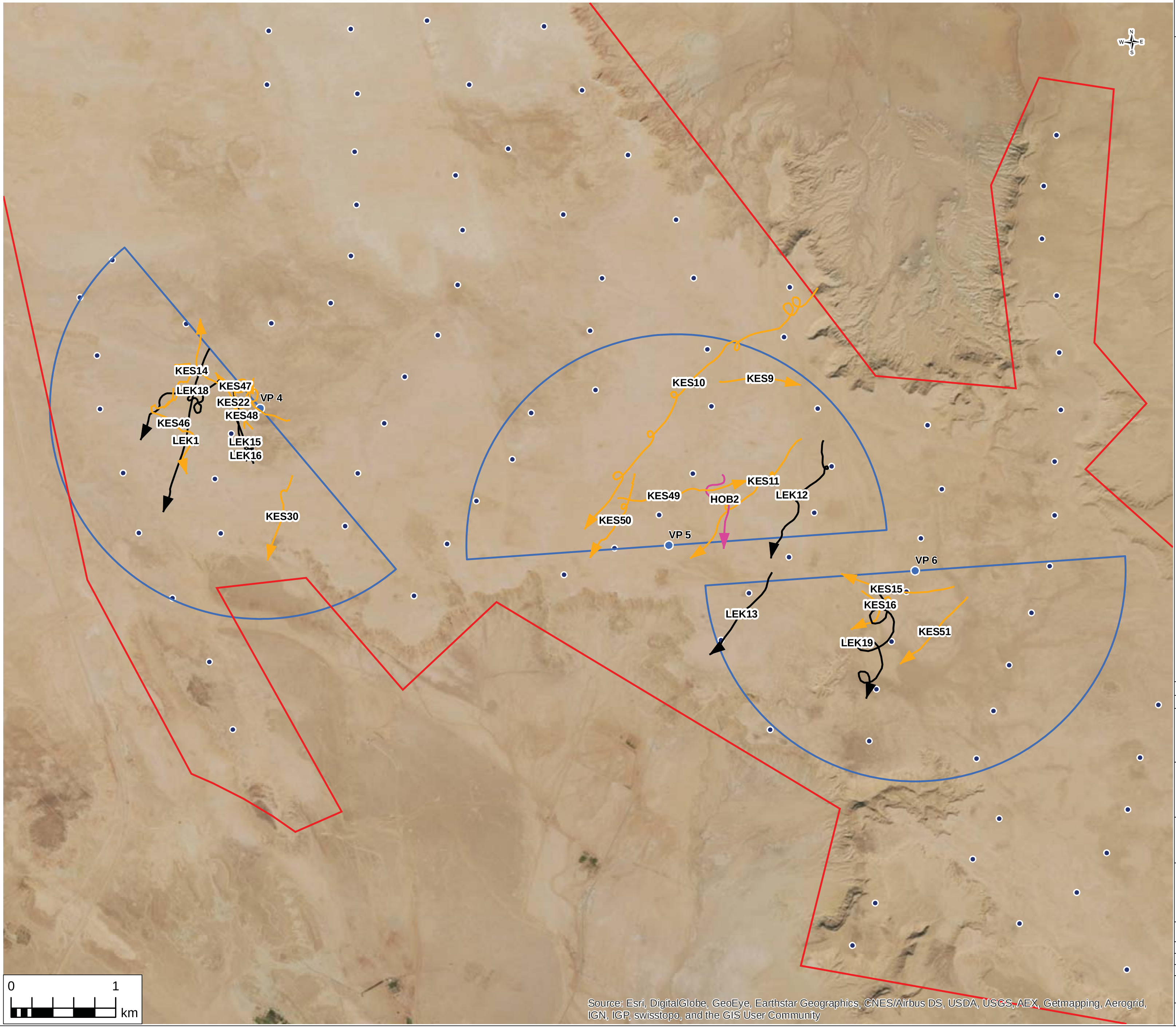
FALCON SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-10	

This drawing is not to be used in whole in or part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.

SA217900-DMT-G-PLN-TB19-11



Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Eurasian hobby
- Kestrel
- Lesser kestrel

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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Client

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Project

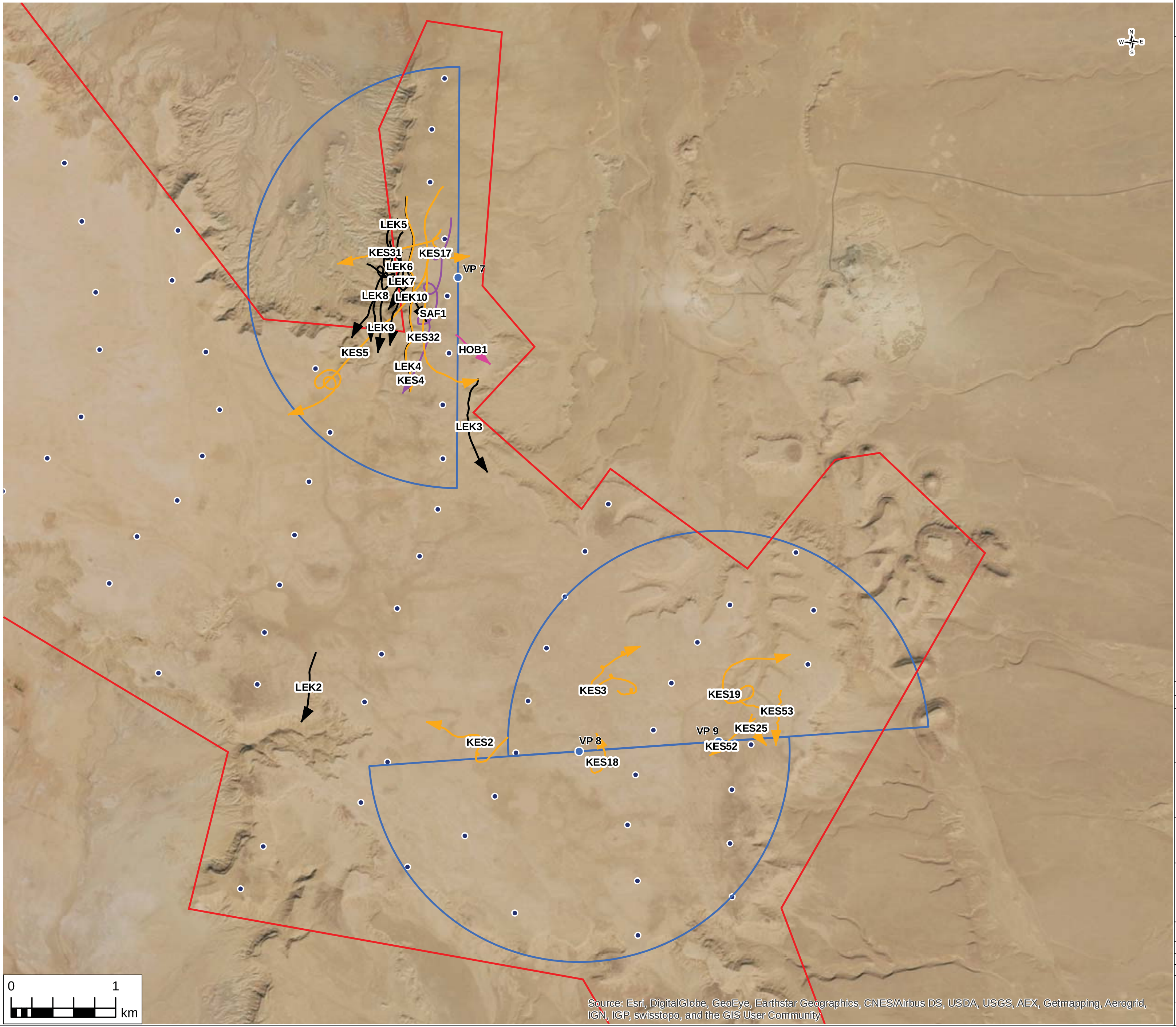
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

FALCON SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-11	



SA217900-DMT-G-PLN-TB19-12

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Eurasian hobby
- Kestrel
- Lesser kestrel
- Saker falcon

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

FALCON SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
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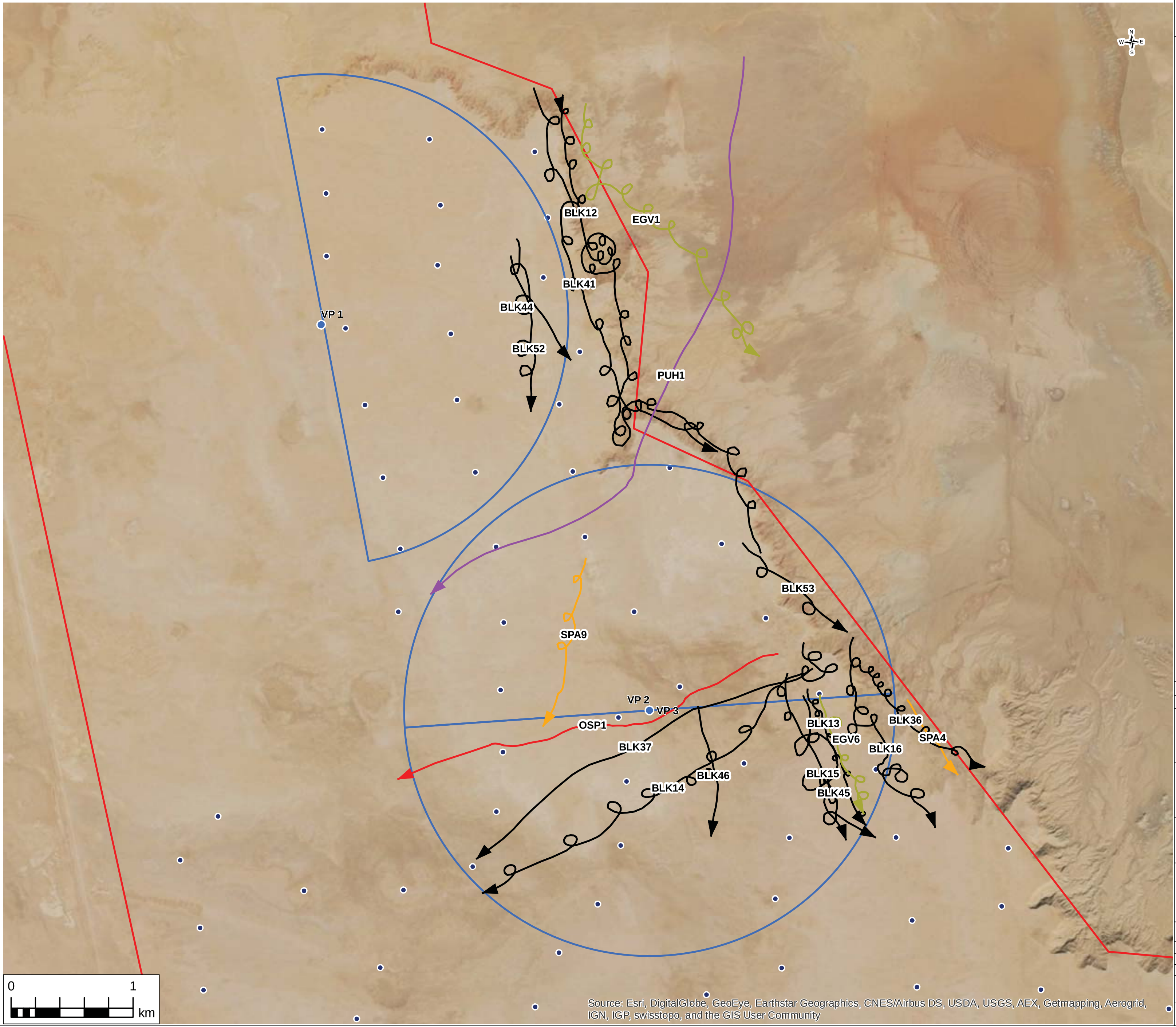

SA217900-DMT-G-PLN-TB19-13

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Egyptian vulture
- Purple heron
- Osprey
- Sparrowhawk
- Black kite

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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Project

DUMAT AL JANDAL WIND ENERGY PARK

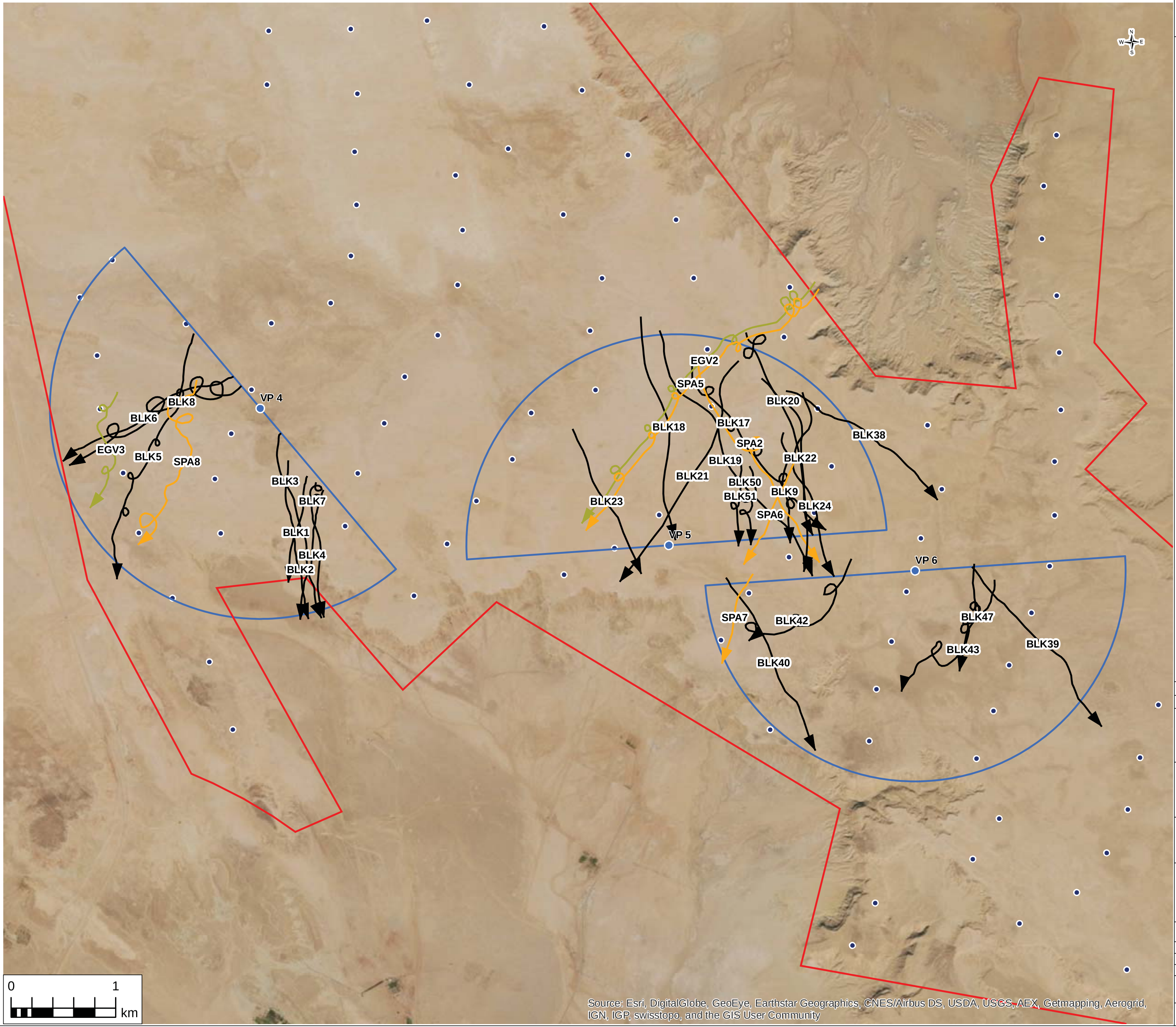
Drawing Title

OTHER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-13	

This drawing is not to be used in whole in or part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.



SA217900-DMT-G-PLN-TB19-14

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Egyptian vulture
- Sparrowhawk
- Black kite

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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Project

DUMAT AL JANDAL WIND ENERGY PARK

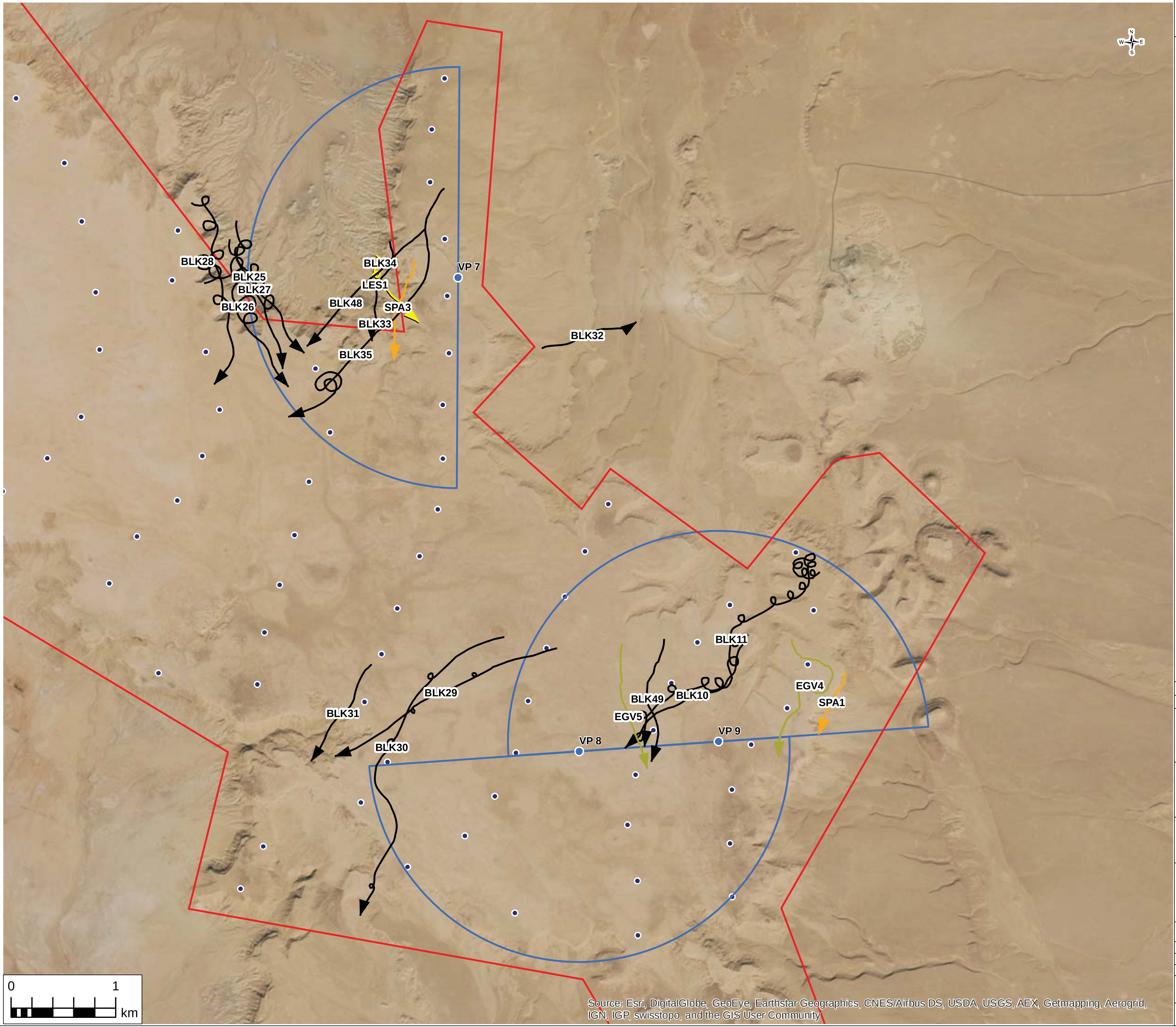
Drawing Title

OTHER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-14	

This drawing is not to be used in whole in or part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.



SA217900-DMT-G-PLN-TB19-15

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Levant sparrowhawk
- Egyptian vulture
- Sparrowhawk
- Black kite

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX,

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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Project

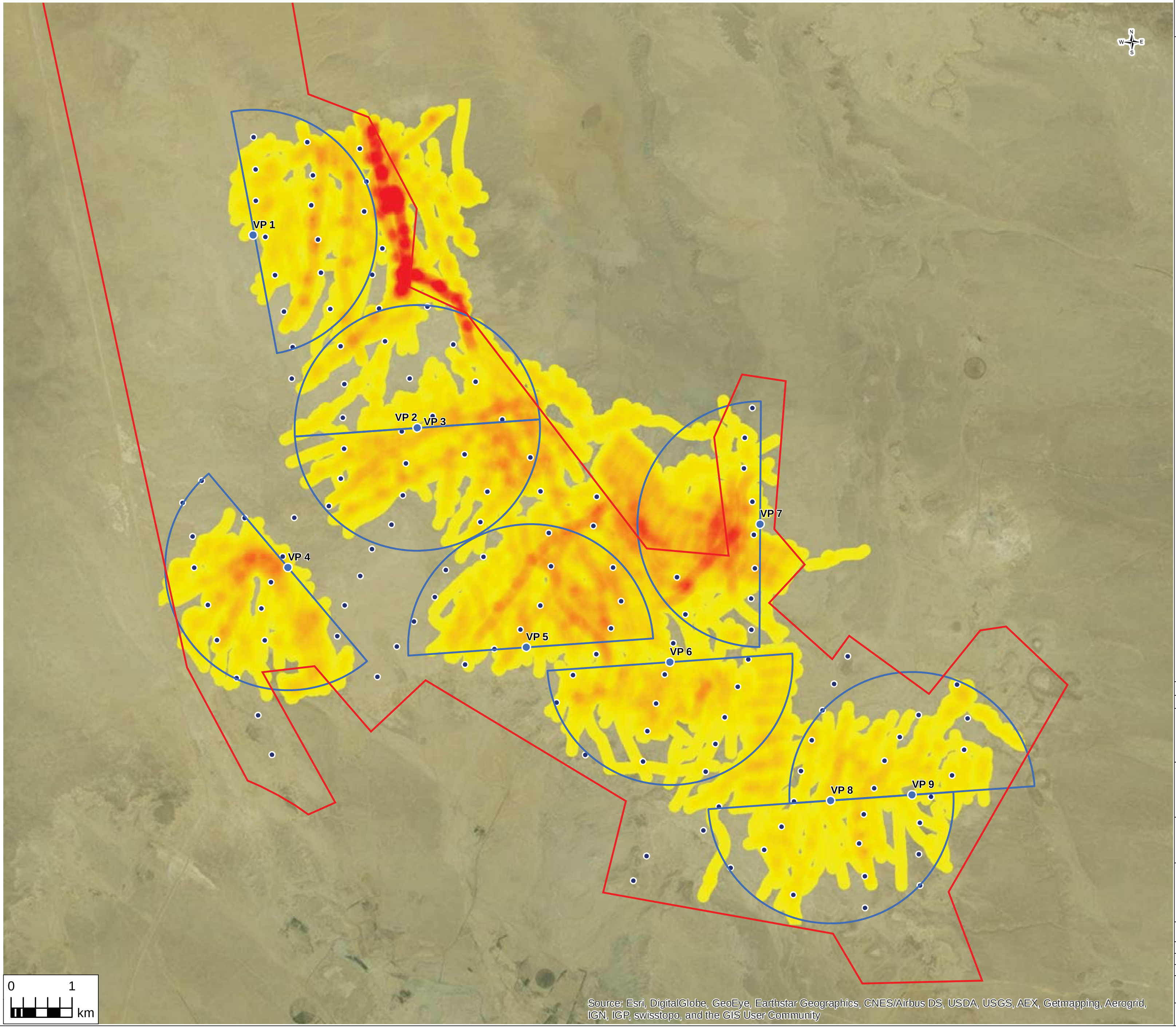
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

OTHER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-15	



SA217900-DMT-G-PLN-TB19-16

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052
- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076
- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Relative Density of Flight Lines

Higher

Lower

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	NOV 17	Initial Issue	IM	AD	AD	MR

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Project

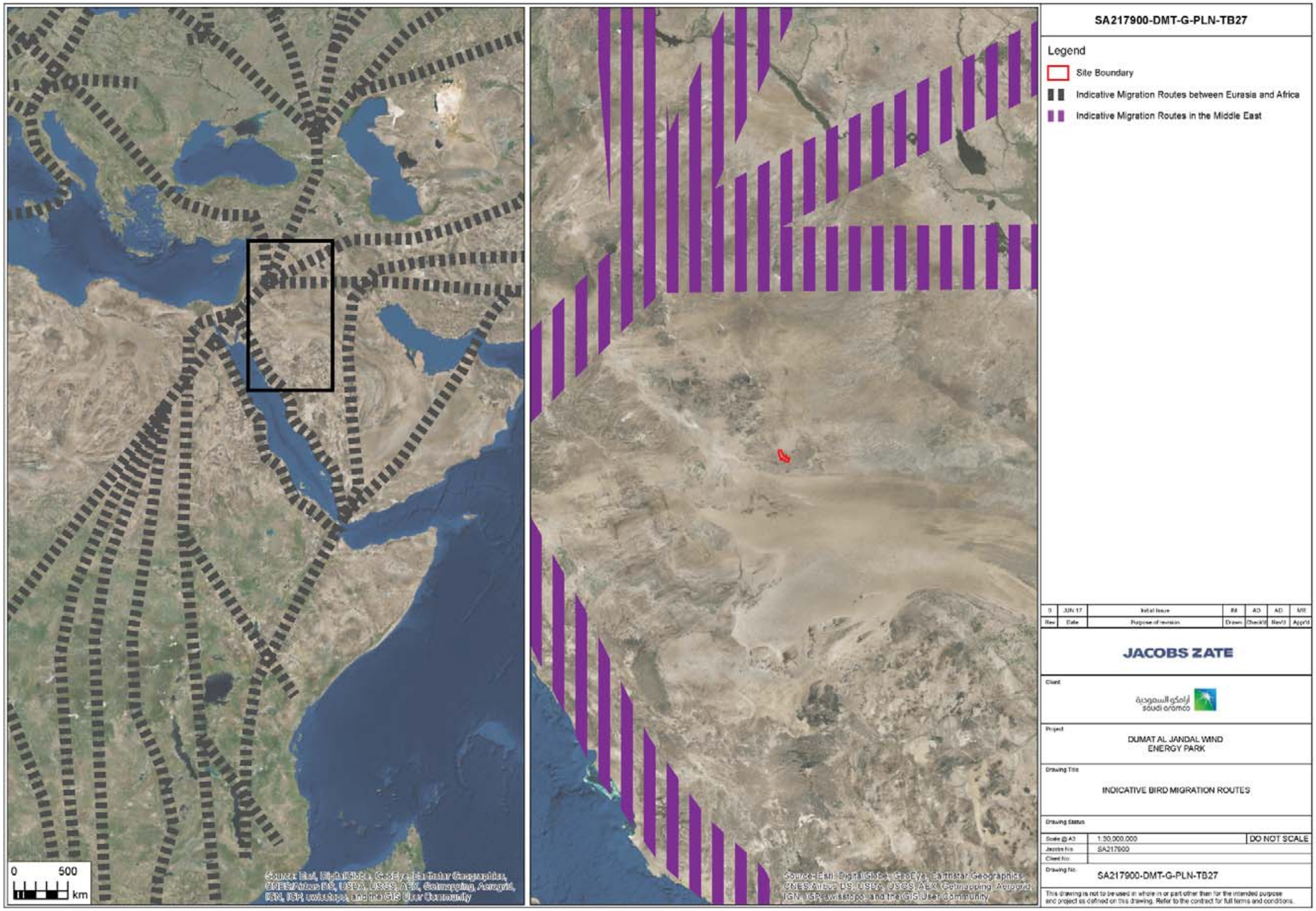
DUMAT AL JANDAL WIND
ENERGY PARK

Drawing Title

ALL SPECIES FLIGHT LINES
SPRING SURVEYS

Drawing Status

Scale @ A3	1:60,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB19-16	


SA217900-DMT-G-PLN-TB27
Legend
Site Boundary
Indicative Migration Routes between Eurasia and Africa
Indicative Migration Routes in the Middle East
0 500 km
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
0 | JUN 17 | Initial Issue | IM | AD | AD | MR
Rev | Date | Purpose of revision | Drawn | Check'd | Rev'd | App'd
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Project
DUMAT AL JANDAL WIND ENERGY PARK
Drawing Title
INDICATIVE BIRD MIGRATION ROUTES
Drawing Status
Scale @ A3 1:30,000,000
DO NOT SCALE
Jacobs No. SA217900
Client No.
Drawing No. SA217900-DMT-G-PLN-TB27
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Appendix G. International Bird and Biodiversity Areas

Jabal Aja (27°30'N 41°30'E, 200,000 ha) lies west and south-west of Ha'il city and is an extensive outcrop of granite mountains with deep valleys. The site is extended north-east to the edge of the Nafud Desert to include an area used for surveys of migrant Grus virgo (Jibal at-Tuwal and Dilan al-Jilf, 27°50'N 41°45'E, 200,000 ha)-an area of flattish semi-desert and sandstone hills, punctuated by medium-altitude granitic mountains with deep valleys. The climate is fairly benign (altitude 800-1,550 m), and the area is one of the greenest in northern Arabia; in wet springs the desert and sandstone hills bloom, and many ephemeral pools and lakes are formed. Valleys in granite mountains are often lined with many Acacia trees. Much of the crane survey area is under wheat cultivation by pivot irrigation systems.

Total area is 400,000 ha.

IBA population trigger species for Jabal Aja

Species	IUCN Category	Season	Period	Population estimate	IBA Criteria
Sand Partridge Ammoperdix heyi	LC	resident	1993	abundant	B3
Demoiselle Crane Anthropoides virgo	LC	passage	1993	5,600 individuals	A4i, B1i, B2
Hume's Owl Strix butleri	LC	resident	1993	present	B3
Egyptian Vulture Neophron percnopterus	EN	resident	1993	10-100 breeding pairs	B2
Griffon Vulture Gyps fulvus	LC	resident	1992	100 breeding pairs	B2
Menetries's Warbler Sylvia mystacea	LC	passage	1993	common	B3
Menetries's Warbler Sylvia mystacea	LC	winter	1993	common	B3
White-throated Robin Irania gutturalis	LC	passage	1993	present	B3
Finsch's Wheatear Oenanthe finschii	LC	passage	1993	present	B3
Finsch's Wheatear Oenanthe finschii	LC	winter	1993	present	B3
Pale Sparrow Carpospiza brachydactyla	LC	breeding	1993	1,000 breeding pairs	B3
Cinereous Bunting Emberiza cineracea	NT	passage	1993	present	A1, B2
A4iv Species group - soaring birds/cranes	n/a	passage	1993	5,600 individuals	B1iv

Harat al Harrah: A huge desert area of northern Saudi Arabia, close to the border with Jordan, and 80 km north-west of Sakaka. Undulating, black, basalt boulder-fields with numerous volcanic cones and frequent low hills, interspersed with silt flats and some sabkhah. Wadis are generally shallow. Rainfall is seasonal (every winter) but varies greatly in amount between years. There is rarely any surface water except for a permanent reservoir at Dumat Al Jandal (see site 002) near the southern edge of the reserve. Except for a very few stunted palms the vegetation is devoid of trees, and is sparse except after good winter/spring rains, although drainage features contain a reasonable cover of small shrubs (Artemisia, Haloxylon, Zilla).

Total area is 1,377,500 ha.

Populations of IBA trigger species at Harat al Harrah

Species	IUCN Category	Season	Period	Population estimate	IBA Criteria
Sand Partridge Ammoperdix heyi	LC	resident	1993	common	A3, B3
Chlamydotis undulata	NR	resident	1993	50 nests	A1, B2
Chlamydotis undulata	NR	winter	1993	570 individuals	A1
Cursorius cursor	NR	breeding	1993	present	A3
Hume's Owl Strix butleri	LC	resident	1993	uncommon	A3, B3
Pharaoh Eagle-owl Bubo ascalaphus	LC	resident	1993	present	A3
Eastern Imperial Eagle Aquila heliaca	VU	winter	1993	uncommon	B2
Saker Falcon Falco cherrug	EN	passage	1993	present	B2
Eremalauda dunni	NR	resident	1993	present	A3
Greater Hoopoe-lark Alaemon alaudipes	LC	resident	1993	present	A3
Thick-billed Lark Ramphocoris clotbey	LC	resident	1993	present	A3
Bar-tailed Lark Ammomanes cinctura	LC	resident	1993	present	A3
Desert Lark Ammomanes deserti	LC	resident	1993	present	A3
Temminck's Lark Eremophila bilopha	LC	resident	1993	present	A3
Finsch's Wheatear Oenanthe finschii	LC	winter	1993	common	B3
Pale Sparrow Carpospiza brachydactyla	LC	breeding	1993	uncommon	B3
Pale Sparrow Carpospiza brachydactyla	LC	passage	1993	frequent	B3

At-Tubayq: This huge area is a raised platform of old, dark sandstone rising 300-400 m above the undulating sandy plain which surrounds it. The ramparts are extremely broken and rocky, precipitous in places, but the plateau is flat. There is no permanent water and, apart from a flush of ephemeral plant growth after rains, vegetation is limited to drought-resistant shrubs (e.g. Haloxylon) and grasses with a few stunted Acacia trees.

Total area is 1,220,000 ha.

Populations of IBA trigger species At-Tubayq

Species	IUCN Category	Season	Period	Population estimate	IBA Criteria
Lappet-faced Vulture Torgos tracheliotos	EN	resident	1993	10 breeding pairs	A1, B2
Hooded Wheatear Oenanthe monacha	LC	breeding	1993	uncommon	B3

Dumat Al Jandal: This site, on the north-east side of Dumat Al Jandal town, is one of the very few remaining wetland habitats in the northern desert. Until 1983-1984 it was a medium-sized natural lake surrounded by a large marsh of reeds and sedges (900 ha overall), but this has now been drained and converted to agricultural smallholdings; the water is pumped to an elevated basin in the hills overlooking the former marsh, forming a reservoir (150 ha). From here water flows through a number of irrigation channels back to the agricultural areas, where there are some very small, scattered remains of marshland. The reservoir is used for recreation in summer, and fish Tilapia have been introduced.

No data is available on populations of IBA trigger species.

Appendix H. Survey Design

H.1 Survey Design

H.1.1 Phase 1 Habitat Survey

A Phase 1 habitat survey was undertaken to record the habitat features within and adjacent to the development site. The standard survey methodology developed by the Joint Nature Conservation Committee (2010) was utilized and adapted for the Kingdom of Saudi Arabia. The aim of Phase 1 habitat survey is to provide a rapid record of vegetation and wildlife habitat over large areas.

The habitat classifications are based principally on vegetation, augmented by reference to topographic and substrate features, particularly where vegetation is not the dominant component of the habitat. This latter aspect is particularly relevant for the development site which includes significant areas which support sparse or no vegetation. Descriptive target notes were taken to give a brief account of particular areas of interest, including vegetative communities. Target notes are an essential part of Phase 1 survey and provide the basis for selection of sites for more targeted species surveys (i.e. Phase 2 survey) and for the assessment of environmental impact.

During the Phase 1 habitat survey habitats across the development site were accessed and sampled to facilitate the classification of habitat type and the identification of flora communities and associations. The relative abundance of flora within the habitat classifications will be reported using the DAFOR scheme which works on % cover, where D = Dominant >75%, A = Abundant 75 - 51%, F = Frequent 50 - 26%, O = Occasional 25 - 11%, R = Rare 10 - 1 %. Cover/abundance is a measure of the vertical projection on to the ground of the extent of the living parts of a species. Desert flora communities are typically sparse with areas devoid of vegetative growth. In the context of the Park, the application of the DAFOR scheme is in relation to the community.

Evidence of faunal species (e.g. tracks, borrows or dens, scats or droppings, hairs etc.) and direct sightings were also recorded during the Phase 1 habitat survey, and landscape features which have the potential to support faunal species were be targeted for survey.

H.1.2 Faunal Surveys Using Trail Cameras

Based on the findings of the Phase 1 habitat survey and identification of faunal activity, Bushnell Trophy Cam trail cameras have been deployed. These cameras use a passive infrared sensor to detect movement within its monitoring range. This triggers the camera to capture still images or videos which are saved onto an internal SD card. These cameras are also equipped with infrared LEDs which allow it to take images during the night or in low light situations.

The trail cameras were deployed where there is existing evidence of faunal activity, and attempt to assist with species identification. The cameras were not baited as experience has shown that this can influence the species recorded on the trail camera. The cameras were left in-situ for a minimum of one full night, including a sun-set and sun-rise, to ensure the activities of crepuscular and nocturnal species were captured.

Table 23-5 lists the locations where trail cameras were deployed and the hours of recording in each location. The locations are also shown on Figure 11.5.

Table 23-5: Deployment Locations of Trail Cameras

Trail Camera Ref	Location	Date Set	Hours Recording	Northing	Easting
A	Vegetated habitat amongst rock faces at top of scree slope.	22nd January 2017	48hrs		
B	Very small/sandy channel with mammal burrow.	24th January 2017	46hrs		

Trail Camera Ref	Location	Date Set	Hours Recording	Northing	Easting
C	Multiple burrow set on hillside at north edge of plateau on the boundary of the development site.	12th March 2017	168hrs	30°04'28.1"N	39°46'17.9"E
D	Sandy channel with *Haloxylon* shrubs in a wadi.	20th March 2017	72 hrs.	29°59'45.7N	39°47'24.5"E
E	Scree slope at the south east edge of plateau.	27th March 2017	72hrs	30°03'24.4"N	39°47'51.2"E
F	Small area of boulder scree in the middle of the development site.	5th April 2017	96hrs	29°59'65.6"N	39°52'98.7"E
G	Open rocky desert in close proximity to VP6.	10th April 2017	24hrs	29°59'18.9"N	39°51'41.4"E
H	Egyptian spiny tailed lizard burrow amongst boulders near a track.	12th April 2017	24hrs	29°59'27.4"N	39°50'34.0"E
I	Small pool in a wadi with many mammal and bird footprints around the muddy edges.	16th April 2017	48hrs	29°58'53.4"N	39°51'14.4"E
J	A second drinking pool in close proximity to the first one which had dried up.	18th April 2017	168hrs	29°58'53.3"N	39°51'15.7"E
K	Small rocky channel in a wadi at the base of a scree slope.	27th April 2017	72hrs	29°58'39.4"N	39°50'47.1"E
L	Base of a cliff in a wadi at the boundary of the development site.	1st May 2017	24hrs	29°59'18.3"N	39°51'42.2"E
M	Wadi system near edge of site plateau.	6th September 2017	140hrs	30o02'35.8"N	39o49'09.8"E
N	Possible fox den.	12th September 2017	120hrs	30o00'07.4"N	39o52'34.2"E
O	Edge of site plateau beneath shaded overhang with signs of mammal use.	18th September 2017	144hrs	29o59'12.1"N	39o51'58.5"E
P	Edge of site plateau in area good for roosting raptors.	25th September 2017	140hrs	30o02'38.6"N	39o49'12.9"E
Q	Edge of site plateau near quarry access route.	3rd October 2017	168hrs	29°59'42.06"N	39°52'44.67"E
R	Open ground near VP4	16th October 2017	72hrs	30° 0'25.58"N	39°47'52.45"E

H.1.3 Bat Activity Surveys

Overview

As documented in the Bat Conservation Trust's *Bat Surveys for Professional Ecologists Good Practice Guidelines* (2016), current research in the US and continental Europe has shown that impacts of wind turbines on bats vary depending on site, species and season. The most commonly documented impacts include:

- direct collision with blades, and
- barotrauma (mortality due to damage to bats' lungs caused by sudden change in air pressure close to the turbine blade (Baerwald *et al* 2008).

Other possible impacts include:

- loss of foraging habitat (due to wind farm construction or because bats avoid the wind farm area); and
- fragmentation of habitat (because wind farms form barriers to commuting or seasonal movements, and due to severance of foraging habitat).

The aim of bat survey is to evaluate the importance of the site for bat species through a preliminary desk based assessment, followed by targeted roost and activity surveys. The following sections outline the survey approaches to be implemented and the survey effort to be deployed.

Wind turbines have been shown to impact bat populations through collision, barotrauma, and disturbance / displacement (Horn *et al.,* 2008; Baerwold *et al.,* 2008; Bach *et al.,* 2004). Therefore it is important to consider their placement carefully in order to minimize their impact to this species group. Baseline data is required in order to identify the risk to bats at each location and from the wind farm as a whole.

There are 39 species of bats known to occur within Saudi Arabia (Al-Agaili, 2003). These 39 species are split between eight families (*Pteropododae; Rhinopomatidae; Emballonuridae; Rhinolophidae; Nycteridae; Hipposideridae; Vespertillionidae*; and *Molossidae*). Of the 39 species, 21 are known to inhabit deserts, and semi-deserts.

Assessing Need for Survey

An assessment for the need for survey will be undertaken in accordance with the Bat Conservation Trust's *Bat Surveys for Professional Ecologists Good Practice Guidelines* (2016). The assessment will evaluate the quality of habitat at the development site and in the wider landscape, and the potential for these areas to support bats. The assessment will take into account:

- the extent and quality of foraging and commuting habitat surrounding and on the site (e.g. *Acacia* woodland and vegetated wadi channels);
- the proximity of the proposed site to protected areas designated for bats; and
- the presence of buildings or other features or structures that may support, or are known to support bat roosts.

The level of risk that the proposed turbine development may have on local bats, both individuals and populations will be classified as low, medium or high risk. Any proposed site that has the potential to regularly support bats may have an impact on bats, although the potential impact is likely to increase in relation to the number and quality of habitat features (BCT, 2016).

Determining Species Specific Risk

In the UK, a collision risk assessment has been prepared for British bat species. The assessment is divided into two parts: first an assessment of the category level of risk of each species based on its ecology (including foraging range and flight height); second an assessment of the populations likely to be most threatened, incorporating information on population estimates (BCT, 2016).

Research in the UK on bat species and collision risk indicates that bat mortality is predominantly (98%) among taxa adapted to open-air foraging (Rydell et al 2010a). Mortality was also found to increase with turbine height and rotor diameter, but is independent of the distance from the ground to the lowest rotor point (BCT, 2016). Further research by Rydell *et al* (2010b) further suggests that mortality of bats at turbines may be linked to high-altitude feeding on insects that may accumulate at the turbine towers.

For the Kingdom of Saudi Arabia, information on the ecology of species and conservation status and vulnerability of populations is limited. Therefore it is not possible to develop a collision risk assessment for each species, specific to Saudi Arabia. Therefore, experience from European bats species and families will be applied to the bat fauna of the Kingdom of Saudi Arabia to generate a provisional collision risk potential.

Roost Surveys

Potential structures within the development site and up to 200m from the boundary, which offer potential roost sites for bats were inspected for the presence of bats. This will include natural roost sites including subterranean caves, crevices and caves within the mountainous region to the north of the site, and man-made structures including the Saudi Port Authority building. A daytime inspection of potential structures and roost sites will be completed, and all evidence of actual bats or the presence of bats (e.g. staining around roost entrances, droppings) will be recorded.

Automated Activity Surveys at Ground Level

Automated Anabat Express detectors were deployed in locations deemed secure and which would enable the collection of representative data on bat activity. On the basis that the site is comprised of predominantly open landscapes with few habitat features and the wind turbines will be located within large areas of homogenous habitat, the survey was limited to a representative sample of turbine locations.

Subject to further evaluation, the Park is assessed as low risk to bat individuals and populations. On this basis and in accordance with the Bat Conservation Trusts good practice guidelines (2016), 5 consecutive nights for each single or pair of locations within the survey area, per season.

Anabat Express automated bat detectors were deployed across the development site during spring 2017. A total of 1,420 hours of recording time using Anabat Express detectors was completed.

Table 23-6: Deployment locations of Anabat Express

Anabat Ref	Date Set	Hours Recording	Immediate Habitat	Northing	Easting
Anabat -1	14/03/2017	184	Edge of plateau	N29˚57'48.4	E39˚54'18.3
Anabat -2	27/03/2017	72	Edge of Plateau	N30˚03'24.4	E39˚47'51.2
Anabat -3	10/04/2017	36	Open ground	N29˚59'18.9	E39˚51'41.4
Anabat -4	16/04/2017	192	Near seasonal pools	N29˚58'53.9	E39˚51'14.7
Anabat -5	27/04/2017	144	Met mast	N29˚57'44.3	E39˚53'51.4
Anabat -6	06/09/2017	144	Open ground.	30º03'15.2"N	39º47'53.1"E
Anabat -7	12/09/2017	120	Edge of site plateau facing out over depression below.	30º01'19.5"N	39º50'28.5"E
Anabat -8	18/09/2017	168	Open ground near VP8	29º57'59.4"N	39º53'11.7"E
Anabat -9	25/09/2017	72	Edge of site plateau facing out over seasonally inundated pools and a cliff lined wadi.	29º53'53.8"N	39º51'14.0"E
Anabat -10	01/10/2017	216	Edge of site plateau in area with steeps-sided wadi valley.	30º02'38.6"N	39º49'12.9"E
Anabat -11	16/10/2017	72	Open ground near VP4	30° 0'25.58"N	39°47'52.45"E

On collection of the Anabat express detector the data was downloaded and sent for analysis by an experienced UK bat ecologist with experience of surveying for bats in the Middle East. The analysis was completed using Analookw W (version 4.1k) to view the files. Each individual file was labelled as being attributed to a species of bat, or as being noise.

Data on the call parameters, known status, and habitat preferences of Saudi Arabian bats was gleaned from a wide range of sources (Davies, 2007; Aspetsberger *et al.,* 2003; Hackett *et al.,* 2014; Zawahreh, 2014; Benda *et al.,* 2006; Benda *et al.,* 2010; Taylor, 1999; Al-Agaili, 2003). The IUCN website (https://www.iucn.org) was used to identify pseudonyms of the species being studied to prevent duplicated effort and consolidate the information available.

Once the information on habitat preferences, echolocation parameters, and known distribution had been collated the recorded echolocation calls were analyzed. Each call identified as a bat was studied; the Saudi Arabian species were ruled out, first on the basis of habitat preference, then on the basis of call parameters. If the call being studied could then still apply to more than one species the known distribution was taken into account. Where the call parameters and habitat preferences of the bats did not match any one species consideration was given to widening the label to genus level.

Subject to further evaluation, the Park is assessed as low risk to bat individuals and populations. On this basis and in accordance with the Bat Conservation Trusts good practice guidelines (2016), 5 consecutive nights for each single or pair of locations within the survey area, per season. The meteorological conditions at the time of survey will be recorded.

Appendix I. Phase I Habitat Notes

Target Note	Northing	Easting	Description
A	30° 4'25.05"N	39°47'45.30"E	Shallow exposed sandy slopes on northern edge of plateau leading out into flat low-lying depression. Multiple indications of faunal activity in this l0ocation; tracks, scat and a likely red fox *Vulpes vulpes* den found nearby.
B	30° 3'48.03"N	39°45'57.91"E	Communication tower and associated solar panel alongside railway line at the western edge of the development site.
C	29°59'55.62"N	39°52'29.83"E	Area of plateau extensively covered by bare ground. Mixed rock of varying densities and size with no vegetation recorded nearby.
D	29°59'16.45"N	39°51'39.55"E	Minor wadi area; typical of the smaller wadi systems and low-lying patches across the majority of the site. Sparse vegetation present primarily consisting of two species; *Acacia sp*. and *Achillea fragrantissima*.
E	30° 0'11.78"N	39°49'33.63"E	Resident farmer who has occupied the site for seven years and tends to a small herd of goats. Anecdotal evidence gathered that he generally doesn't see many animals, including birds, except when a carcass of any deceased livestock is left out. He lives in a mobile caravan located centrally on-site. *[Since the baseline survey in spring 2017 this farmer has left the site]*
F	29°57'43.97"N	39°54'13.64"E	Eastern edge of plateau, medium-sized slopes of boulder scree run down to the valley below, no vegetation recorded. Overhead powerlines run north to south approximately 2km from site with sporadic farms/settlements also visible.
G	30° 0'14.96"N	39°51'31.25"E	Exposed edge of plateau with roughly 45º slopes of mixed-size rock scree leading down to the undulating topography within the vast lower-lying depression north of the development site.
H	30° 0'21.17"N	39°51'14.63"E	Edge of plateau, sandy bare ground slope with rock coverage and sparse *Acacia sp.* presence.
I	30° 0'33.40"N	39°51'9.35"E	A remote trail camera was situated at this location surrounded by shallow bare rock faces at the top of a vegetated (primarily *Achillia fragrantissima*) slope at the edge of the plateau. As is typical across the development site the bare ground rock coverage extends right to the edge of the plateau which is evident here. Red fox *Vulpes vulpes*, jird *Meriones* spp. and multiple bird species were recorded by the trail camera.
J	30° 1'48.95"N	39°50'8.45"E	Sheer cliff face at the edge of the plateau surrounded by steep scree slopes of boulder. No vegetation recorded.
K	30° 2'38.37"N	39°49'16.60"E	Ravine cutting into plateau; slopes of scree and sheer cliff faces line the steep-sided valley. Geological layering of rock clearly visible. No vegetation recorded.
L	30° 2'36.33"N	39°49'9.70"E	Sheer cliff faces line a wadi ravine at this location.
M	30° 3'26.01"N	39°49'16.22"E	A single specimen of *Anastatica hierochuntica* was recorded at this location in an otherwise barren rocky environment. A Pharoah eagle owl pellet was also recovered.
N	30° 4'11.36"N	39°48'59.17"E	Recent rock collapse evident at the edge of the plateau. As is typical of the site, bare rock coverage runs to the very edge of the plateau with no vegetation noted.

Target Note	Northing	Easting	Description
O	29°58'9.69"N	39°52'0.50"E	Typical wadi run-off area at the edge of the site plateau. Scree-slopes lining a sparsely vegetated (*Acacia sp.*) small wadi valley below.
P	29°57'53.45"N	39°51'18.78"E	Boulder outcrop of the darker, molten-type rock found on site.
Q	29°57'59.19"N	39°51'27.22"E	Flat area of low-lying silt/mud as part of a small and shallow wadi system on the plateau. Sparse vegetation recorded (*Achillia fragrantissima*)
R	29°58'21.01"N	39°51'14.05"E	Clear boundary of the two commonly found rock types on site. Lighter sandstone rock and the darker, molten-type rock. Both found in mixed densities across site although boulder of the dark rock more prevalent in this area. No vegetation recorded.
S	29°58'39.52"N	39°50'39.76"E	Steep-sided ravine that cuts into the plateau. Scrubby wadi habitat sparsely covers the ravine basin. Access not possible although *Acacia* spp. dominant of the vegetation visible from distance.
T	29°58'39.96"N	39°50'57.58"E	Ravine shallows out into a wider wadi depression lined by scree; *Acacia* spp. dominant of the vegetation present.
U	29°58'56.56"N	39°50'16.84"E	Wadi basin which cuts into the plateau edge. *Acacia* spp. most prevalent.
V	29°59'7.18"N	39°48'40.34"E	Edge of plateau, small farm visible from this part of site. One large circular irrigated crop and multiple groups of livestock (goat) in the low-lying area below to the south.
W	29°59'26.52"N	39°48'26.05"E	Edge of plateau, the southwest peninsula of site lies on the other side of a wide, stepped, valley. The base of the valley is flat and made up of typical wadi-type habitat although access was not possible.
X	30° 0'12.95"N	39°48'8.85"E	Boulder outcrop on small hill. Two to three other hills of similar nature nearby surrounding one of four Saudi Aramco metrological masts on-site. Rock not as large on the other hills although all darker molten-type rock.
Y	29°59'45.55"N	39°47'23.19"E	Start of wadi run-off area; opening up to the wide wadi valley below which leads out to the farming area to the south, lying between the southwest peninsula and the main plateau. *Acacia* spp. and *Achillia fragrantissima* recorded. Primitive livestock enclosure of wood and wire nearby.
Z	29°58'14.85"N	39°47'48.52"E	End of southwest peninsula, very exposed location with good views over scattered farms stretching to the south. The rock-type is mixed with steep sandstone scree edges although primarily the darker, molten-type rock on the plateau with no vegetation coverage.
AA	29°59'12.99"N	39°46'49.01"E	Area between railway bridge and south-west peninsula largely covered by former earthworks and heavy machinery activity. Thought likely to be related to the construction of the railway and bridge.
AB	30° 0'25.82"N	39°49'37.06"E	Typical bare rock coverage of the site with no vegetation recorded.
AC	30° 0'28.59"N	39°47'39.87"E	Significant wadi area; most densely vegetated area found on-site. Five to six species of plant present; *Acacia* spp. and other species recorded.
AD	30° 0'31.14"N	39°48'6.63"E	Low-lying sandy/vegetated wadi area.

Target Note	Northing	Easting	Description
AE	30° 0'48.90"N	39°46'52.48"E	Extensive area of earthworks; likely seismic survey. Regular patterns in sectional forms; continues towards railway. Less rock coverage, more bare sand.
AF	30° 1'16.37"N	39°46'38.35"E	Small sandy wadi channel with burrow on edge of extended earthworks/seismic survey. Remote trail camera deployed here recorded red fox *Vulpes vulpes*, jird *Meriones* spp. and multiple bird species. *Acacia* spp. only vegetation recorded.
AG	30° 1'44.04"N	39°47'27.32"E	Peak of hill, notable from satellite imagery; overlooks two flat wadi/gravel areas to east and west. Dark rock coverage on hill whereas lighter rock/gravel and sand within sparsely vegetated wadi areas below.
AH	30° 2'30.85"N	39°47'56.45"E	Bare rock coverage with no vegetation; representative of 'typical' rock coverage across the majority of the site plateau.
AI	30° 2'44.21"N	39°46'45.00"E	Small mammal burrows recorded within small vegetated area (*Citrullus colocynthis* and *Acacia* spp. General bare ground habitat continues from this location to the extensive earthworks along the western edge of site (railway line).
AJ	30° 3'51.18"N	39°46'36.82"E	Small mammal burrows within sandy vegetated area (*Achillia fragrantissima*). Many small prints and tracks of birds, small mammals and probable lizards.
AK	30° 4'28.13"N	39°46'17.87"E	Shallow hills surround the northern extent of the plateau in this area. Multiple medium-sized mammal burrows found in these hills; one with multiple entrances in a ‘sett’-type structure presumed connected beneath ground.
AL	30° 4'44.87"N	39°46'54.87"E	Large open wadi system extending north from the site plateau. Dense vegetation cover recorded; primarily *Achillia fragrantissima*.
AM	30° 5'17.60"N	39°46'58.21"E	Red fox *Vulpes vulpes* carcass.
AN	30° 3'52.44"N	39°47'24.75"E	Significant wadi/low-lying gravel area running north: *Acacia* spp. less common here but *Achillia fragrantissima* widespread.
AO	30° 2'47.02"N	39°48'52.06"E	Significant wadi area/low-lying gravel area running north to south. Signs of moisture evident in the area dominated by *Achillia fragrantissima* coverage.
AP	30° 1'16.24"N	39°48'40.97"E	Typical bare rock coverage of the site; extremely sparse *Acacia sp.* the only vegetation cover at minimal density (<1%).
AQ	29°57'34.94"N	39°53'23.35"E	Short green growth in low-lying areas (*Achillia fragrantissima*) this was only recorded towards the east end of the plateau, very sporadic.
AR	29°57'0.69"N	39°53'37.38"E	Boulder scree slopes typical across the entire southeast edge of the plateau. No vegetation recorded.
AS	29°56'46.10"N	39°53'58.95"E	The southeast corner of the development site is situated on an entirely separate plateau. This area of the site is typical bare ground rock coverage, with no vegetation. Extensive scree slopes line the edges of both plateaus.
AT	29°57'1.82"N	39°54'16.88"E	A small land holding is visible from this point near the edge of site. A residential tent and a fenced off area used to cultivate small trees noted.
AU	29°57'17.04"N	39°54'23.21"E	Typical bare rock coverage across extensive areas in this part of the development site. No vegetation recorded.

Target Note	Northing	Easting	Description
AV	29°58'13.22"N	39°54'42.55"E	Typical bare rock coverage across extensive areas in this part of the development site. No vegetation recorded.
AW	29°58'30.46"N	39°54'27.76"E	Wadi running into low-lying area; *Acacia* spp. recorded. Plateau continues north seemingly all of the same bare rock type although this access was not accessed.

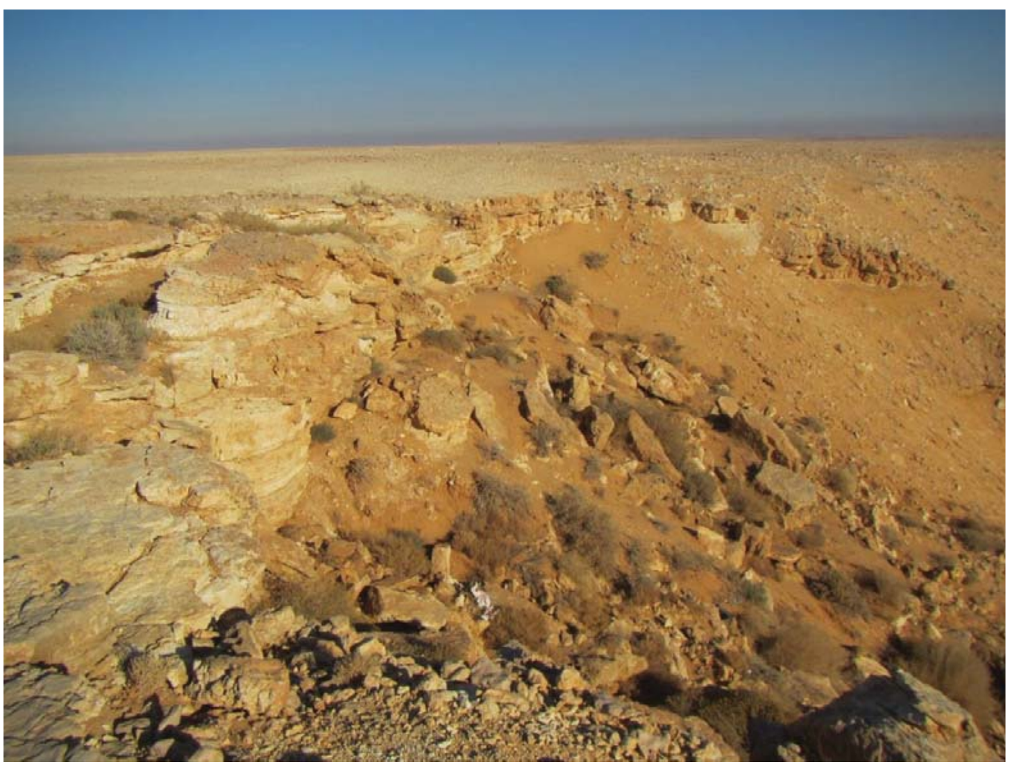
Appendix J. Phase I Photographs

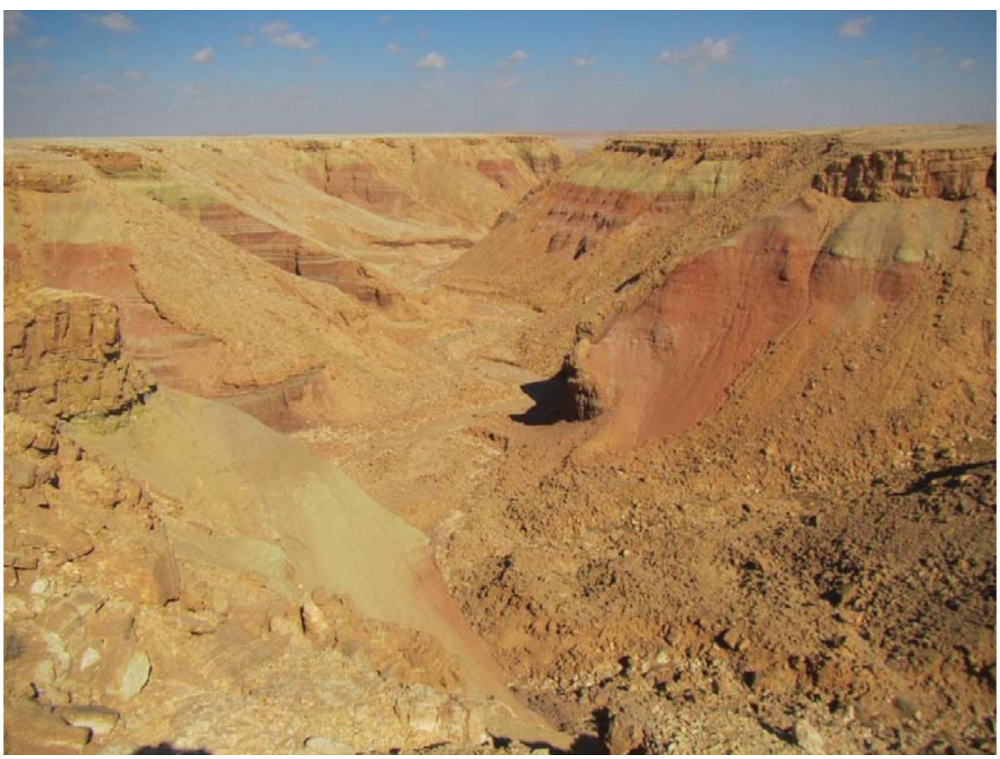
Target Note	Image
A	

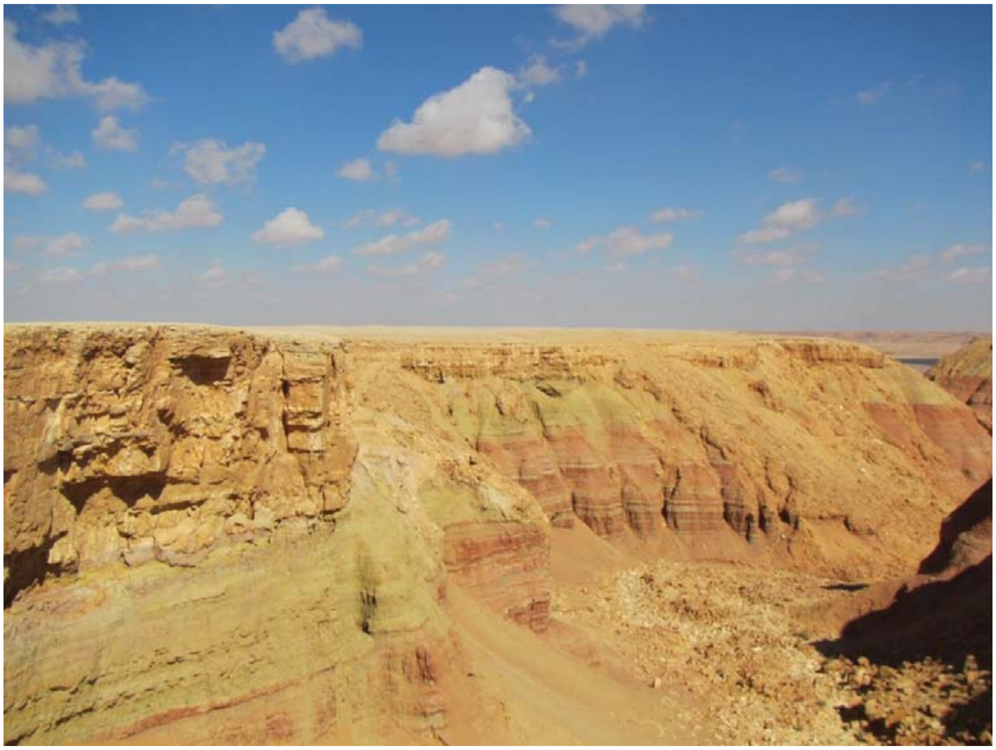
B	
C	

D	
E	

F	
G	

H	
I	

J	
K	

L	
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AP	
AQ	

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AS	

AT	
AU	

AV	
AW	

Appendix K. Radar Assessment

JACOBS Consultancy

Dumat al Jandal

Saudi Aramco

Radar and Communication impact assessment

Final | Rev 3

06 March 2018

60K48600

Dumat al Jandal

Project No: 60K48600
Document Title: Radar and Communication impact assessment – Dumat al Jandal
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Project Manager: C Raymond
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Revision	Date	Description	By	Review	Approved
Draft	12/12/2017	Draft for Issue	Daisy Adewusi	Paul van Lieshout	Paul van Lieshout
Rev 0	06/02/2018	Final Report	Daisy Adewusi	Paul van Lieshout	Paul van Lieshout
Rev 1	07/02/2018	Final Report – changes based on client comments	Daisy Adewusi	Paul van Lieshout	Paul van Lieshout
Rev 2	26/02/2018	Final Report – changes based on client comments	Daisy Adewusi	Paul van Lieshout	Paul van Lieshout
Rev 3	06/03/2018	Final Report – changes based on client comments	Daisy Adewusi	Paul van Lieshout	Paul van Lieshout

Contents

Table of Abbreviations

Abbreviation	Meaning
AM	Amplitude modulation
CAA	Civil Aviation Authority
CFAR	Constant False Alarm Rates
EM	Electromagnetic
EMI	Electro Magnetic Interference
FAA	Federal Aviation Authority
FM	Frequency Modulation
GACA	General Authority of Civil Aviation of Saudi Arabia
ILS	Instrument Landing System
LORAN	LOng RAnge Navigation
LoS	Line of sight
OLS	Obstacle Limitation Surface
PSR	Primary Surveillance Radar
PNT	Positioning, Navigation and Timing
RABC	Radio Advisory Board of Canada
RCS	Radar Cross Section
SEC	Saudi Electricity Company
SRTM	Shuttle Radar Topography Mission
SSR	Secondary Surveillance Radar
STL	Studio to Transmitter Links
TTL	Transmitter to Transmitter Links
VOR	VHF Omnidirectional Range

Executive Summary

The objective of the study is to establish potential impacts of the proposed Dumat al Jandal Wind Energy Park development on identified radar and communication infrastructure in the vicinity of the proposed development. This document therefore describes the radar and communications impact study carried out by Jacobs Consultancy for the proposed Park using information provided and publicly available information.

The assessment has been carried out using the layouts provided in the preliminary design documents [1], information received during preliminary stakeholder engagements and is based on worst case scenario analysis. e.g. the use of maximum set back as advised in international guidelines. (These are in cases where stakeholder guidance has not been clearly provided.)

The Dumat al Jandal Wind Energy Park will be installed on an area of approximately 71 km^2 with an installed capacity of approximately 400MW.

The salient characteristics of the wind turbines used in this study are as follows:

Table 1 : Proposed wind farm characteristics

	Dumat al Jandal Wind Farm
Max number of turbines in project	132
Tower height	155 m
Rotor diameter	140 m
Tip height	225 m
No of blades	3
Blade material and Radar Cross Section of individual turbines [1]	Not available

From the assessment carried out, it is concluded:

- There is likely to be minimal to no negative impact to the civil aviation operations at Al Jouf airport by the proposed development based on letter of No Objection provided by GACA after an obstacle evaluation was requested and carried out by GACA.
- While the 6km setback distance, as stipulated by the Ministry of defence, has been adhered to; it is important that consultation with the Ministry of defence be held to determine there is no potential impact of the Park to their radar systems as instrumentation specifics were not provided or reviewed at the time of writing.
- Using the EUROCONTROL guideline of recommended ranges, and based on its distance to the airport, Dumat al Jandal Wind Park, should fall within the Zone 3 or 4, assuming the radar at Al jouf is a Primary Surveillance Radar (PSR). This will mean that a simple assessment would be required, should it be established that the proposed Park is within maximum instrumented range and in radar line of sight of the Radar.

[1] *It is important to note that at this stage of the project the turbines have not been selected and therefore the dimensions and materials and more importantly for this study the Radar Cross Section (RCS) are unknown and likely subject to change. This coupled with additional unknowns in regards to radar systems (primary, secondary as well as filtering capability to reduce clutter) it would provide uncertainties such that results would be meaningless at this stage.*

- Using the EUROCONTROL guideline of recommended ranges, if the radar is a SSR (classical, monopulse and Mode S), the impact of the wind turbine should be considered to be tolerable. [4] as the proposed Park is further than 16km.

- The telecommunication facilities in the vicinity of the Park requires further analysis to determine the Fresnel zones of associated microwave paths and ensure the location of individual wind turbines in the wind farm does not compromise telecommunication signals (point-to-point).

Due to the distance between the wind farms and the telecommunication equipment (including radar) it is not expected that the Park as a whole will cause a negative impact on the near field of the telecom/radar installations; if there is any impact it will be due to individual turbines, which can be individually addressed should it be required.

Id	Receptor	Classification	Stakeholder	Potential Impact	Potential Mitigation
1.	Al Jouf airport	Airport – Civil and Military	GACA / Ministry of Defence	Consultation with GACA for obstacle evaluation has resulted in a letter of No Objection being issued for the turbine height of 225m. Ministry of Defense radar facility	None required except substantial changes are made to the coordinates submitted to GACA. Further consultation with the Ministry of Defense is required to ensure there is no impact to their radar system as instrumentation details were not provided for this assessment.
2.	Communication Masts		Unknown	Using just the setback distance of 1km, it does not appear that the turbines will impact the telecoms tower.	It is necessary to consult with stakeholders; owners and operators to agree buffer around telecoms masts and identify Fresnel zone clearance if required resulting in possibly some local adjustment of a number of turbines within the wind farm area. Further, re-routing of microwave paths might have to be considered.

1. Introduction

1.1 Overview

Saudi Aramco is assessing the feasibility of a wind energy Park with a total capacity of up to 400MW at Dumat al Jandal.

Jacobs Consultancy was tasked with identifying the impacts these proposed developments could have on radar and communication receptors in the vicinity of the developments. In this study Jacobs Consultancy have used a combination of ArcGIS, a geographic information system (GIS) and SRTM data to compile geographic information and analyse line of sight of identified receptors and highlight potential aviation and communications constraints to the proposed development at Dumat al Jandal. In the absence of site specific safe guarding, Jacobs has employed the worst case scenario analysis to identify impacts; i.e. assuming that full Radar Cross Section (RCS) which is where the full rotor can be seen.

Radar in this report is a term used to encompass devices designed to transmit or receive radio signals. These signals typically provide bearing and range data from a given point to targets of interest. Radars considered in this study can have both civil and military applications and cover aviation, maritime or meteorological services. In addition to conventional radar services, the potential impact on communications systems including telecommunications transmissions and navigation aids is analysed in this report.

Historically, the radars and communication services that have proved to be more sensitive to the presence of wind turbines are the following:

1. Primary Surveillance Radars (PSR) and Air Traffic Control radars,
2. LORAN-C systems,
3. Secondary Surveillance Radars (SSR),
4. Weather radars and maritime radars,
5. aeronautical navigation systems such as VOR and ILS;
6. fixed radio links; and
7. broadcasting services (mainly analogue television; digital television to a lesser extent).

Potential impact must be analysed on a case-by-case basis, taking into account the particular features of each installation and the involved services, such as the accurate location of the wind turbines and the telecommunications infrastructure, telecommunication towers height, service frequency and modulation, radiating systems characteristics and reception conditions, terrain altimetry, topography, surface texture such as vegetation which varies over seasons and time, and waterbodies. In addition, the characteristics of the wind turbine will need to be taken into account particularly height and RCS of the ‘visible part of the turbine structure’.

The following sections describe the desktop study based Radar and Communications assessment carried out by Jacobs Consultancy for the proposed Dumat al Jandal Wind Energy Park, highlighting the potential impacts on the identified infrastructure and where possible identifying potential stakeholders with whom pre-construction consultation would be required.

In this assessment, Jacobs Consultancy has used Saudi Arabian legislation as well as international guidelines as best practice guidance when identifying potential impacts and making recommendations.

This study is by no means an extensive list of the potential stakeholders as the assessment is based on a desktop search of the developable area of the Park and client local information. It is also noted that a ‘generic’ wind turbine is used in the study and it is recommended to repeat the study when a target wind turbine has been selected (particularly in regards to the radar cross section of the turbine). A full stakeholder consultation will need to be carried out in due course.

1.2 Salient Turbine Characteristics that affect Radar and communication systems

Turbine characteristics which affect the wind turbine and wind farms influence on radar and communication systems include

- Turbine layout and turbine height
- Blade and tower materials
- Non aerodynamic components within the blade including lightning protection and sensors
- Tower dimensions
- Nacelle dimensions, layout and material

1.3 Wind farm effects on radio communication systems

The presence of wind farms near communication transmitters or receivers may introduce distortions on the transmitted signals. These distortions can cause different effects on the radio communications services depending on several factors such as:

- the frequency band
- the modulation scheme
- the discrimination of the radiation pattern of transmitter and receiver aerials

Other impacts include;

1.3.1 Shadowing

Large obstacles, such as buildings, hills or wind farms can create shadowed areas blocking the line of sight from the receiver to the transmitter. These areas can be broken down into two regions: Region “A” where signal loss, due to the blockage, is high and receiving a usable signal is difficult if not impossible; and Region “B” where the signal is attenuated but to a lesser degree than in “A” allowing the receiver to continue to pick up a usable signal. The size of each of the areas depends upon the shape and composition of the obstacle. Typically, Region “B” can extend up to 10 km from the obstacle. It is important to note that shadowed zones are also height dependent.

1.3.2 Mirror Reflections

Mirror-type (specular) reflections are caused when the signal from the transmitter bounces off an obstacle before being received at the antenna. This bounced signal has a longer path than the direct signal, causing it to be delayed in time at the receiver; in addition, the bounced back signal is much weaker due to the longer path and not full reflection as some of the energy of the beam will have been absorbed by the ‘mirror’. In a conventional AM receiver, when the two signals are received simultaneously and one is delayed, the delayed signal can degrade the direct signal. In extreme cases, degradation can also occur in FM receivers. These reflections mainly occur in the back scatter zone.

1.3.3 Scattering

When a radio communication signal reaches a wind turbine, the rotating blades of the turbine can produce a pulsed scattering of this signal synchronized with the rotational speed of the blades. These pulses can add a Doppler effect to the signal, which produces variations in the scattered signal’s phase and amplitude. This scattering mainly occurs in the front scatter zone, but can also occur in the back scatter zone.

In the front scatter zone, which encompasses an area behind the wind turbine of approximately 72 degrees in width, the effect is analogous to shadowing, with the signal varying in amplitude and phase synchronously with the speed of the blades’ rotation. In the back scatter zone, which encompasses the remaining 288 degrees of arc, the effect is similar to a mirror reflection. However, here again, the scattered signal contains both phase and amplitude variations.

1.4 Wind farm effects on Radar Systems (Aviation, weather)

The determination of the effect of wind turbines on radar systems is not straightforward

If a wind farm is in direct line of sight to radar it may have a detrimental effect upon radar performance, as the (rotating) blades can be a source of interference (RCS). Where wind turbines are in `line of sight' to the radar, the turbines can appear as genuine aircraft (helicopter) obstacles. The turbines could mask real aircraft responses or desensitise the radar within the radar sector/cell containing the wind farm, thereby potentially creating interference and flight safety issues.

Knowing that a certain cell contains ‘reflections’ from wind turbines, then this ‘clutter’ can be removed from the radar screen. However, this ‘blanking of cells’ (if possible by internal filters using Doppler) could ‘blank’ out actual aircraft going over that particular radar cell. Filtering static object is commonplace in radar technology to avoid radar screen clutter.

Common impacts of wind farms on radar systems include:

1.4.1 Clutter

The presence of wind farms near radar sites can potentially introduce ‘clutter’ on radar displays (depending on how many radar cells are affected, which is a function of distance from the radar site.

Radar clutter is defined as “Unwanted signals, echoes, or images on the face of the radar display tube, which interfere with observation of desired signals”. Clutter occurs when radar signals are returned from objects like aircraft, but also buildings and topographical obstacles. The return signals from aircraft are desired. The last are ‘filtered’ to not ‘clutter’ the radar display. This filtering can rather easily be done by looking at the reflected signals and identifying Doppler effects which occur with moving targets (no Doppler effect from buildings or topographical obstacles).

Wind turbines might reflect signals with a Doppler signature due to the rotation of the rotor (depending of the wind direction and relative alignment of the wind turbine versus the radar) and as such there are possibilities that ‘erroneous signals appear on the radar screen (albeit static and not moving as if it were a helicopter, illuminating constantly a small ‘cell’ on the radar screen (for as long as the wind direction and wind speed is correct to provide a positive Doppler signal). Note that radar operators will quickly become accustomed to a single illuminated cell from a wind turbine.

The return signal from a target or obstacle (like a wind turbine) depends on a number of variables, including:

- ‘Line of sight’ (note not the visual light line of sight but the radar beam line of sight which is calculated using an enlarged earth radius – see below)
- The ‘Radar Cross Section’ (σ) of the turbine, which is a measure of how detectable an object is. This depends on the physical size of the object/turbine and particularly on the blades. But this also depends on the orientation i.e. wind direction as discussed above.
- Distance between the radar antenna and the turbines. However, this is not an inverse linear relation but related to the inverse of the distance to the fourth power (1/R^4), which means a doubling of the distance reduces the return signal by a factor 16. Depending on the signal to noise ratio this might be undetectable depending on the RCS and other meteorological parameters.

1.4.2 Blockage

A single turbine in close proximity or a wind farm at a limited distance to a radar site can block a certain 'angular sector of limited height', of the radar beam. Potential severe blockage could lead to a loss of meteorological data, which could affect the radar's operational performance (e.g. storm detection, rainfall/snowfall rate and lower level wind shear) hence potentially causing extreme weather conditions to go undetected.

Given the potential serious impacts of blockage on Air Defence or Air Traffic Control Radars, the threshold for an unacceptable level of blockage would even be less than the 10% occulation of the beam width.

1.4.3 Other

The above issues are the salient effects that wind turbines can have on primary radar communication. Secondary radar works on a different principle namely a signal sent by the radar is received by the aircraft which then respond on a different frequency with information about the aircraft including height, speed etc. This information is displayed next to the position on the radar screen which was obtained by the 'reflection' of the primary radar signal.

Other issues with wind farms and radar are similar to other communication systems using EM wave technology which are described further in this document and include the above mentioned shadowing, reflections, scattering but also near field issues.

2. Project Description

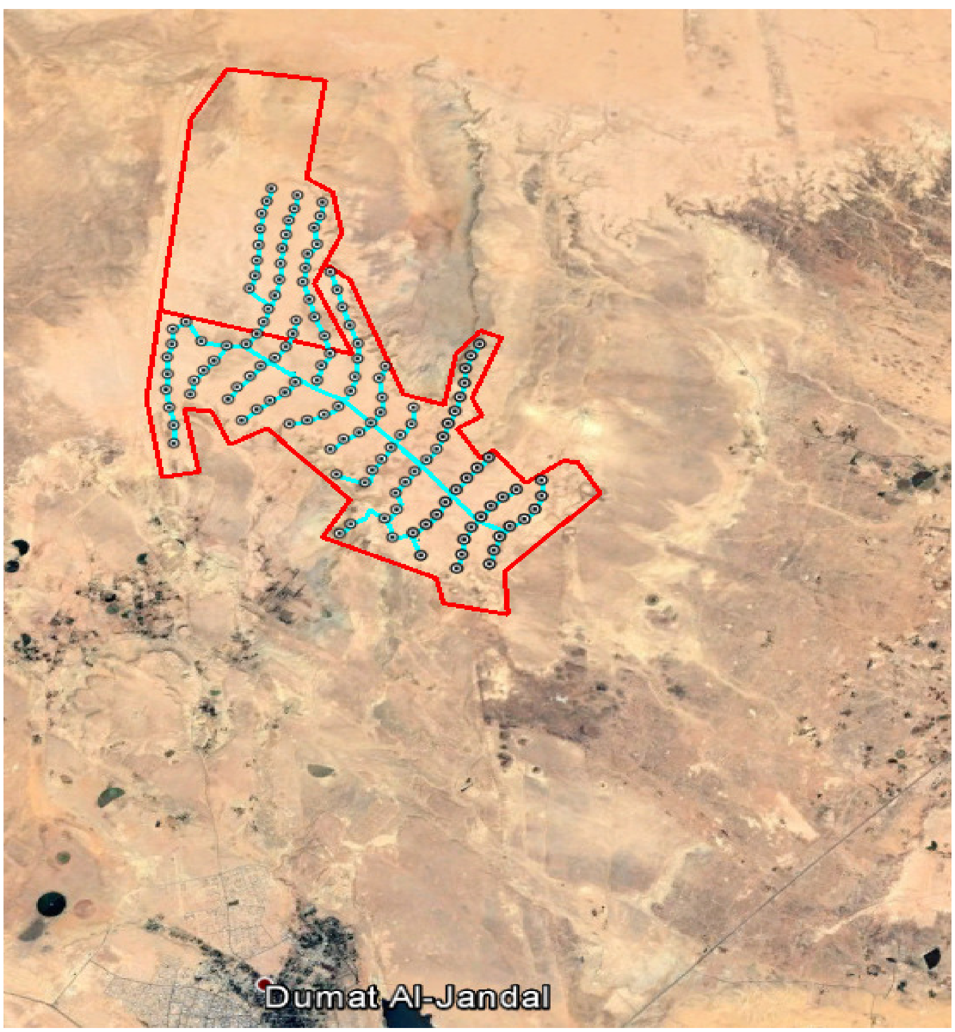
2.1 Dumat Al Jandal Wind Energy Park

The Project is located to the North of Dumat Al-Jandal, Al Jouf Province in northern Saudi Arabia. It is proposed that the Dumat Al-Jandal Wind Energy Park will utilize wind technology on an area of approximately 71 km^2, and is expected to have a total installed capacity of approximately 400 (MW). The Park will be implemented during a single phase.

The proposed development will consist of approximately 130 Wind Turbine Generators (WTGs) with a maximum height of up to 225 meters (m) i.e. 155 m hub height and 140m rotor diameter, and an associated grid interconnection, including a medium voltage/high voltage (MV/HV) sub-station and HV overhead lines connecting the sub-station to the national electrical transmission system owned by the Saudi Electricity Company (SEC).

When fully implemented the Park is expected to generate approximately 1,100 Giga-Watt hours (GWh) per annum. Construction of the Project is expected to start in 2018, will take approximately 20 months and is expected to be in operation for 20 years.

Figure 2.1 : Location of proposed Dumat al Jandal Wind Energy Park



3. Assessment Methodology

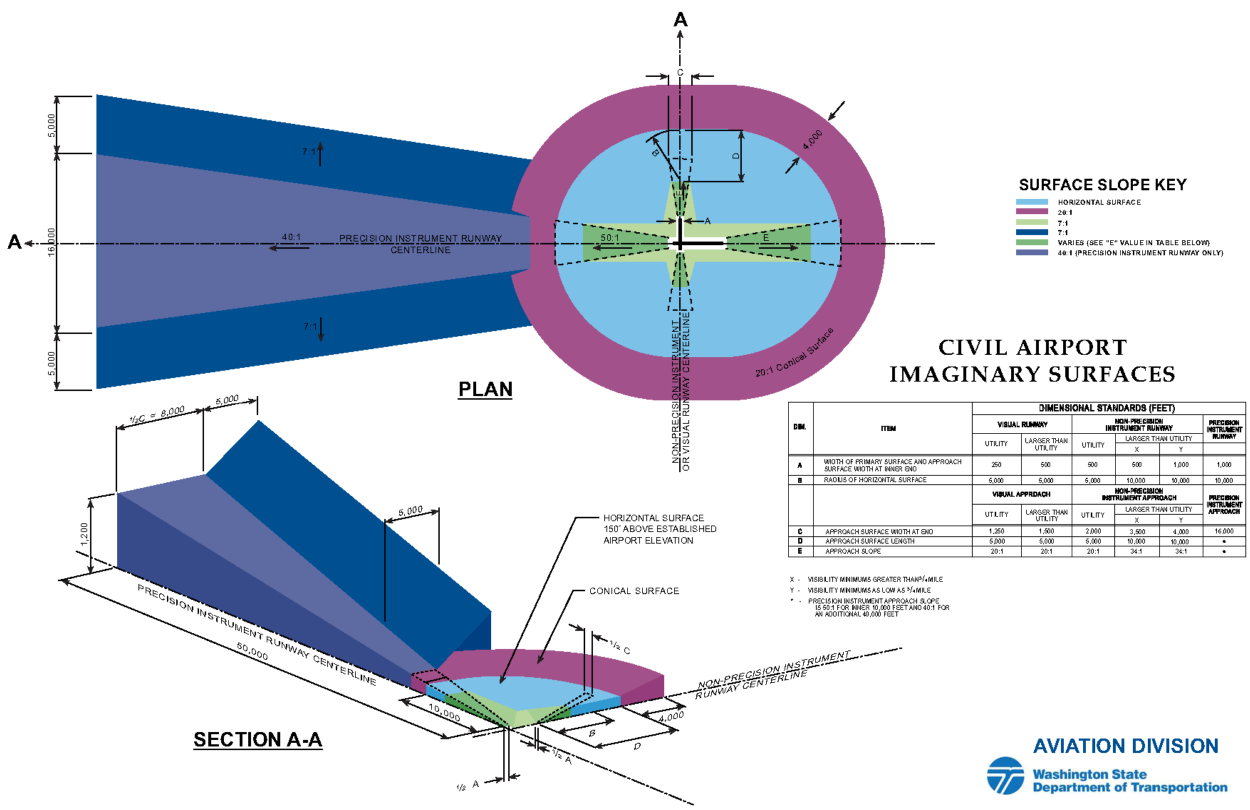
3.1 Aviation related assessment methodology

3.1.1 Obstacle limitation surfaces and ranges

Wind turbines can also present a physical obstruction for certain aviation activities, such as airport arrival and departures for aircrafts. Aircraft activity around aerodromes is normally safeguarded using obstacle limitation surfaces (OLS).

The Obstacle Limitation Surfaces (OLS) are a series of surfaces that set the height limits of objects around an aerodrome. Objects that project through the OLS become obstacles. The OLS may comprise the following individual surfaces: outer horizontal surface, conical surface, inner horizontal surface, approach surface, inner approach surface, transitional surface, inner transitional surface, baulked landing surface; and take-off climb surface and are defined around runways, typically extending approximately 30km in range in the UK.

Figure 3.1 : Obstacle Limitation Surfaces



DIM.	ITEM	DIMENSIONAL STANDARDS (FEET)					
		VISUAL RUNWAY		NON-PRECISION INSTRUMENT RUNWAY			PRECISION INSTRUMENT RUNWAY
		UTILITY	LARGER THAN UTILITY	UTILITY	LARGER THAN UTILITY X	LARGER THAN UTILITY Y	
A	WIDTH OF PRIMARY SURFACE AND APPROACH SURFACE WIDTH AT INNER END	250	500	500	500	1,000	1,000
B	RADIUS OF HORIZONTAL SURFACE	5,000	5,000	5,000	10,000	10,000	10,000
		VISUAL APPROACH		NON-PRECISION INSTRUMENT APPROACH			PRECISION INSTRUMENT APPROACH
		UTILITY	LARGER THAN UTILITY	UTILITY	LARGER THAN UTILITY X	LARGER THAN UTILITY Y	
C	APPROACH SURFACE WIDTH AT END	1,250	1,500	2,000	3,500	4,000	16,000
D	APPROACH SURFACE LENGTH	5,000	5,000	5,000	10,000	10,000	*
E	APPROACH SLOPE	20:1	20:1	20:1	34:1	34:1	*

X - VISIBILITY MINIMUMS GREATER THAN 3/4 MILE

Y - VISIBILITY MINIMUMS AS LOW AS 3/4 MILE

* - PRECISION INSTRUMENT APPROACH SLOPE IS 50:1 FOR INNER 10,000 FEET AND 40:1 FOR AN ADDITIONAL 40,000 FEET

If a proposed wind turbine lies inside the boundary of one of the surfaces and exceeds its minimum height, the aerodrome may object on the basis that the structure is a physical obstruction and poses an unacceptable risk of collision.

For this assessment, GACA have carried out the Obstacle assessment during consultation period in response to an Obstacle Evaluation Request Form submitted.

4. Guidelines for Wind Turbines Impact Assessment on Aviation and Radar Systems

There are several guidelines and regulations aiming at minimising or eliminating the impact of interferences caused by wind turbines on radar and telecommunication instrument and equipment.

The ways these impacts are assessed vary based on instruments and prevailing government policy. In assessing the impacts of the proposed developments on the aviation, Jacobs consultancy have referred primarily to prevailing Saudi Arabian Legislation and in addition, UK and US safeguarding regulations, as best practice guidance. Specifically, the following have been taken into consideration:

1. General Authority of Civil Aviation (GACA) of the Kingdom of Saudi Arabia - GACA Regulations[2]
2. EUROCONTROL Guidelines
3. CAA Policy and Guidelines on Wind Turbines CAP764 – Safety & Airspace Regulation Group3 and
4. FAA Airspace Obstruction Standards
5. Technical Trials

A search of available resources indicates that the International Civil Aviation Organisation (ICAO) does not appear to have published any specific guidelines for wind energy development in proximity to aerodromes, and ICAO has not specified any mandatory or unofficial safeguarding zones. It can be concluded that there is no single international normative that is applied worldwide for the development of wind energy power plants in proximity to civil aerodromes or military assets. The Civil Aviation Authority for each country has typically developed its own specific guidance, or adopted the standards of others, for obstacle management in proximity to civil aerodromes. This is true for Military and defence departments in various countries.

The radar and communications assessment study for Dumat al Jandal has considered ICAO Doc 15. European Guidance Material on Managing Building Restricted Areas. It should be noted that in the absence of published Ministry of Defence guidelines, civil aviation standards have been adhered to.

4.1 Aviation Guidelines

4.1.1 Saudi Arabia General Authority of Civil Aviation (GACA) Regulations

GACA currently oversees economic and safety regulation, air navigation services and the operations of Saudi Arabia's 27 existing airports comprising 5 international, 9 regional and 13 domestic airports with a collective passenger throughput of 75 million as of 2014.

With respect to obstructions in navigable airspace, guidance obtained from the GACA website GACAR Part 77.15 - Construction or Alteration Requiring Notice relating to air space safety states that:

> *(a) If requested by the President, or if a person proposes any of the following types of construction or alteration, it must file notice with the President of—*
>
> > *(2) Any construction or alteration that would penetrate the obstacle notification surfaces prescribed in Appendix A for any aerodrome in paragraph (a)(3) of this section, and in particular:*

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[2] https://gaca.gov.sa/scs/Satellite?blobcol=urldata&blobheader=application/pdf&blobheadername1=Content-Disposition&blobheadervalue1=inline&blobkey=id&blobtable=MungoBlobs&blobwhere=1442842623818&ssbinary=true

[3] https://publicapps.caa.co.uk/docs/33/CAP764%20Issue6%20FINAL%20Feb.pdf

(i) Any construction or alteration that will be within 2.7 NM (5 km) radius of an existing or proposed aerodrome, and the overall height of the structure is more than 33 ft. (10 m) AGL at its site.

(ii) Any construction or alteration that will be more than 2.7 NM (5 km), but less than 10 NM (18.5 km) radius of an existing or proposed aerodrome, and the overall height of the structure is between 33 ft. (10 m) and 150 ft. (46 m) AGL at its site.

(iii) Any construction or alteration that would be in an instrument approach area.

With respect to aeronautical studies and determinations, guidance obtained from the GACA website GACAR Part 77.43 and 77.45 - Construction or Alteration Requiring Notice relating to air space safety states that:

The President will initiate an aeronautical study when the President determines a study is necessary. The President may require the aeronautical study to be prepared by the sponsor of any proposed construction or alteration for which a notice is submitted under this part.

To evaluate Aeronautical Effect;

These studies include, inter alia, evaluating—

(1) The impact on arrival, departure, and en-route procedures for aircraft operating under visual flight rules (VFR);

(2) The impact on arrival, departure, and en-route procedures for aircraft operating under IFR;

(3) The impact on existing and planned public-use aerodromes;

(4) Aerodrome traffic capacity of existing public-use aerodromes and public-use aerodrome development plans received before the issuance of the final determination;

(5) Minimum obstacle clearance altitudes, minimum altitudes, approved or planned instrument approach procedures, and departure procedures;

(6) The potential effect on air traffic control (ATC) radar, direction finders, ATC tower line-of-sight visibility, and physical or electromagnetic effects on air navigation, communication facilities, and other surveillance systems; and

(7) The aeronautical effects resulting from the cumulative impact of a proposed construction or alteration of a structure when combined with the effects of other existing or proposed structures.

GACA does not appear to have published any specific guidelines for wind energy development in proximity to aerodromes, and GACA has not specified any mandatory or unofficial safeguarding zones outside those stated above. In addition, in the absence of Ministry of defence specific guidelines, civil guidelines have been used to access impact to airport radar equipment.

4.1.2 European Organisation for the Safety of Air Navigation (commonly known as EUROCONTROL)

EUROCONTROL is an intergovernmental organisation with 41 Member and 2 Comprehensive Agreement States. Within EUROCONTROL Wind Turbine Task Force (WTTF) specifically created to help define a common European methodology to assess and avoid/minimise the potential impact of wind turbines. The WTTF was composed of civil and military representatives from European Civil Aviation Conference (ECAC) states, service providers and industry.

A set of guidelines on "How to assess the potential impact of wind turbines on surveillance sensors" was made available to recommend methodology, which reflects the experience gained and includes provision for emerging techniques and technologies which can help alleviate interference issues, as well as, propose possible mitigation measures against the impact of wind turbines on ATC radar surveillance. It must be noted that the application of EUROCONTROL guidelines is not mandatory; and has therefore been used to: complement ICAO Recommended Practices and Procedures, complement EC legislation; encourage the application of best practice.

Ultimately as with the spirit **of** Article 8 and 9 of the European Commission (EU) Regulation No. 139.2014, EUROCONTROL does not impose minimum distance requirements for new development in proximity to aerodromes, as the obligation is on Member States to implement procedures for obstacle management in the aerodrome surroundings as well as to other activities taking place outside the aerodrome's boundary; and each Member State may designate different authorities and other entities in charge of monitoring, assessment and mitigation risks.

4.1.3 United Kingdom Civil Aviation Authority (CAA) Policy and Guidelines on Wind Turbines CAP764 – Safety & Airspace Regulation Group

The CAA guidelines outline a specific distance whereby wind turbines falling within such distance have the potential to impact on aviation facilities and therefore their impact needs to be analysed.

Aerodromes.
Whilst not definitive, it should be anticipated that any wind turbine development within the following criteria might have an impact upon civil aerodrome - related operations:

1. *Unless otherwise specified by the aerodrome or indicated on the aerodrome's published wind turbine consultation map, within 30 km of an aerodrome with a surveillance radar facility. The distance can be far greater than 30 km depending upon a number of factors including the type and coverage of the radar and the particular operation at the aerodrome;*

2. *Within airspace coincidental with any published Instrument Flight Procedure (IFP) to take into account the aerodrome's requirement to protect its IFPs;*

3. *Within 17 km of a non-radar equipped licensed aerodrome with a runway of 1100 m or more;*

4. *Within 5 km of a non-radar equipped licensed aerodrome with a runway of less than 1100 m;*

5. *Within 4 km of a non-radar equipped unlicensed aerodrome with a runway of more than 800 m;*

6. *Within 3 km of a non-radar equipped unlicensed aerodrome with a runway of less than 800 m.*

As stated in CAA Policy and Guidelines on Wind Turbines CAP764, "*the figures above are for initial guidance purposes only and do not represent definitive ranges beyond which all wind turbine developments will be approved or within which they will always be objected to. These ranges are intended as a prompt for further discussion between developers and aviation stakeholders in the absence of any other published criteria*".

4.1.4 Federal Aviation Authority (FAA) Airspace Obstruction Standards

American Federal law requires that the FAA determine whether a structure that is proposed to be built or altered, 200 feet above ground level (AGL) or higher, or near an airport, does not pose a hazard to the airspace. To remain consistent with changes to the Code of Federal Regulation (CFR) Part 77 and avoid confusion with previous regulations, the height of a structure identified as an obstruction has been lowered slightly from 500 feet (AGL) to 499 feet (AGL).

Therefore, all structures above 499 feet are considered obstructions and the FAA will continue to conduct an aeronautical study on these types of structures to determine their effect on the navigable airspace and ensure they do not create a hazard.

4.1.5 Technical trials

The impact assessment also refers to the results of the following technical trials which describe the impacts of wind turbines on radar and telecommunications systems:

- United Kingdom Ministry of defence (MOD) aircraft trials describing and illustrating the effects of wind turbines on air defence (AD), air traffic control (ATC) radars, and precision approach radar (PAR) (MOD, 2005a; MOD, 2005b; ADATS, 2009); and

- Trials reports describing and illustrating the impacts of offshore wind turbines on marine radar and telecommunications systems (QinetiQ and MCA, 2004; MCA, 2005; Marico Marine, 2007).

Four trials, covering the areas of GPS, VHF communications and radar tracking and radar clutter were performed by QinetiQ. The QinetiQ GPS trial involved traversing previously defined courses through and around the wind farm. Along each course, the number of satellites visible to two different GPS systems (a Garmin 152 and a Garmin GPSIII) and the position of the ship were recorded.

The QinetiQ radar shadowing trials provided very little evidence that shadowing of targets would present any significant problems. In particular, the shadowing observed was, like the VHF trials, less than predicted in the theoretical study. Clutter in the radar display due to the presence of wind turbines was found to be quite considerable.

Both ring-around and false plots were observed (referred to by mariners as side-lobe, multiple and reflected echoes). The observed problems could be suppressed successfully by using the gain and range settings of the radar. However, this may have the unwanted side-effect of no longer being able to detect some small targets.

4.2 Radar Impact Assessment

4.2.1 Line of Sight

Line of sight (LoS) is defined as the line between two points; specifically, the straight path between a transmitting antenna and a receiving antenna when unobstructed by the horizon. This analysis is commonly used as a baseline assessment of whether an object will be detectable by radar and, thus, have an impact on its operation and has been carried out for this assessment. If the turbines are located in a way that does not affect the surveillance sensor performance (e.g. the turbines are fully ‘hidden’ from the sensors by terrain or the turbines are located further away than the radar instrumented range), then consent for the development can be approved.

Stakeholders are normally satisfied that if the radar antenna does not have LoS to a turbine then it will not be detected.

However, because radar signals diffract over obstacles such as mountains and human constructions, this is not always true; in extreme cases, turbines can be detected by radar systems even when they are not in LoS and further analysis or testing must be completed in order to satisfy stakeholders.

EUROCONTROL guidelines to assessing the potential impact of Wind turbines on Surveillance sensors gives the following guidelines for Primary (PSR)and secondary surveillance Radars (SSR).

Table 4.1 : PSR Recommended ranges[4]

Zone	Zone 1	Zone 2	Zone 3	Zone 4
Description	0 -500m	500 m - 15 km and in radar line of sight	Further than 15 km but within maximum instrumented range and in radar line of sight	Anywhere within maximum instrumented range but not in radar line of sight or outside the maximum instrumented range.
Assessment Requirements	Safeguarding	Detailed assessment	Simple assessment	No assessment

Table 4.2 : SSR Recommended ranges[5]

Zone	Zone 1	Zone 2	Zone 4
Description	0 -500m	500 m - 16 km but within maximum instrumented range and in radar line of sight	Further than 16 km or not in radar line of sight
Assessment Requirements	Safeguarding	Detailed assessment	No assessment

[4] http://www.eurocontrol.int/sites/default/files/publication/files/20140909-impact-wind-turbines-sur-sensors-guid-v1.2.pdf

[5] https://www.icao.int/EURNAT/EUR%20and%20NAT%20Documents/EUR%20Documents/015%20%20Building%20Restricted%20Areas/ICAO%20EUR%20Doc%20015%20Third%20Edition%20Nov2015.pdf

5. Guidelines on Wind Turbines Impact Assessment Communication Systems

Wind turbines, as with any large structure, can potentially interfere with electromagnetic signals. This can affect communications networks and the various systems associated with aeronautical radio navigational aids, and as well as telecoms radio systems and cellular/mobile network.

Impact on radio communication systems can be divided in two parts:

- impact on broadcast-type systems (including cellular type networks); and
- impact on point-to-point systems (including local microwave, studio to transmitter links (STL) and transmitter to transmitter links (TTL); either one-way or two-way) and point-to-multipoint systems).

Propagation effects are mainly associated with the type of radio frequency modulation used (AM or FM/PM) and impacted areas and mitigation measures differ depending on such frequency and nearby obstacles.

5.1 Telecommunications

5.1.1 Over the Air Reception (Radio and TV Broadcasting)

Best practice guidelines from the Radio Advisory Board of Canada (RABC) recommend 1 km consultation zones around radio and television broadcasting antennas. In addition, further investigation is recommended when receivers are within consultation zone defined by:

R= 0.051*B* T

Where: **R**: Radius of consultation zone [km] from geographical centre of proposed wind farm

B: Length of wind turbine blades [m]

T: number of turbines in wind farm

5.1.2 Fresnel zone clearance

Fresnel zones are used by propagation theory to calculate reflections and diffraction loss between a transmitter and receiver. Fresnel zones are numbered and are called ‘F1’, ‘F2’, ‘F3’ etc. There are an infinite number of Fresnel zones, however, only the first 3 have any real effect on radio propagation.

A Fresnel zone is a cylindrical ellipse drawn between transmitter and receiver. The size of the ellipse is determined by the frequency of operation and the distance between the two sites.

$$r_F = 17.3 * \sqrt{d1 * d2 / (d * f)}$$

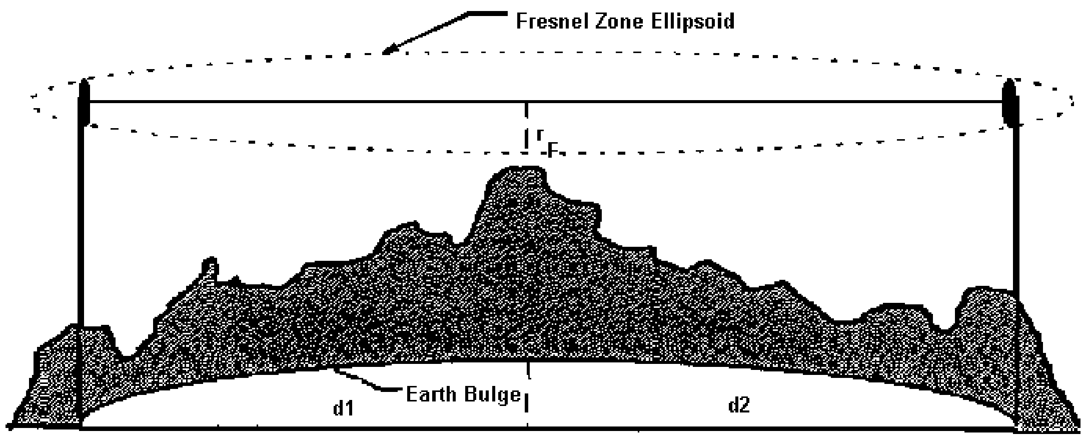
r_f is the Fresnel Zone Radius at the location of interest i.e. the distance of the turbine under investigation versus the transmitting/receiving telecom tower

f represents the frequency

d represents the total path or distance between the two[6] telecom towers where d = d1 + d2

[6] *Note that the provided information does not link the provided telecom towers to a 2nd telecom tower. In order to calculate the Fresnel radius at the particular wind turbine locations this information is required (distance between the two towers and frequency of beam).*

(see diagram below)



6. Identified Receptors and Stakeholder Consultation

6.1 Identified Receptors

From the above guidelines and regulations, a number of receptors were identified in order to provide an initial estimate of the potential impact of the proposed Dumat al Jandal Wind Energy Park on nearby radar and communication equipment.

The following receptors were considered during the Radars and communication risk assessment based on proximity to the proposed development.

Table 6.1 : Radar and Communications receptors identified within Dumat Al Jandal Wind Energy Park vicinity

Id	Receptor	Coordinates	Classification	Stakeholder	Antenna Height	Distance to site
1	Al Jouf airport	29.783583 N 40.090123 E	Airport – Civil and Military	GACA, Ministry of Defence	Unknown	25km
2.	Communication Mast	28.154531 N, 34.761295 E	Unknown	Unknown	Unknown	570m
3.	Communication Mast 1	28.091986 N 34.589127 E	Unknown	Unknown	Unknown	843m

These receptors are analysed in detail in the next sections.

6.2 Stakeholder Consultation

Jacobs Zate, alongside the Renewable Energy Project Development Office, initiated stakeholder consultation as part of the preliminary impact assessment. The following bodies were consulted;

6.2.1 General Authority for Civil Aviation (GACA)

The General Authority for Civil Aviation (GACA) has been consulted on the proposed development of the Dumat al Jandal wind energy Park, and specifically an Obstacle Evaluation Request Form was submitted. The evaluation of obstacles and obstructions in the vicinity of airports is critical to air safety and guidance is provided in GACAR Part 77.01 provide guidance for the evaluation of risk.

GACA has confirmed that they have no objection to the development of the Dumat al Jandal wind energy Park, and the installation of wind turbines with a tip height of 225m.

6.2.2 Ministry of Defence

The Ministry of Defence has been consulted on the proposed development of the Dumat al Jandal wind energy Park. The Ministry of Defence specified a preference for no renewable energy development within 6km of Al Jouf military base, although the basis for this safeguarding zone has not been provided. The Ministry of Defence has also requested that a radar impact assessment is undertaken to determine whether the installation of turbines will have a negative effect. This study should be completed to international standards.

The Ministry of Defence has not provided any information relating to the type of radar utilized at the base, details of any low flight areas, national air defence infrastructure or air traffic control facilities at the base.

6.2.3 Communication and Information Technology Commission (CITC)

The Communication and Information Technology Commission has been consulted on the proposed development of the Dumat al Jandal wind energy Park, specifically for information relating to telecommunication services and infrastructure. CITC shared geo-spatial data which indicates that there are no telecommunication facilities related to service providers within the developable area of the wind energy Park. Communication infrastructure is located to the south of the Park.

7. Receptor Assessment at Dumat Al Jandal Wind Energy Park

7.1 Al Jouf (Identified Receptor 1)

Al Jouf Domestic Airport (AJF), is a joint military and civil airport, located in the vicinity of Al Jouf in Saudi Arabia. AJF has one runway designated 10/28 with an asphalt surface measuring 3,661 by 45 metres.

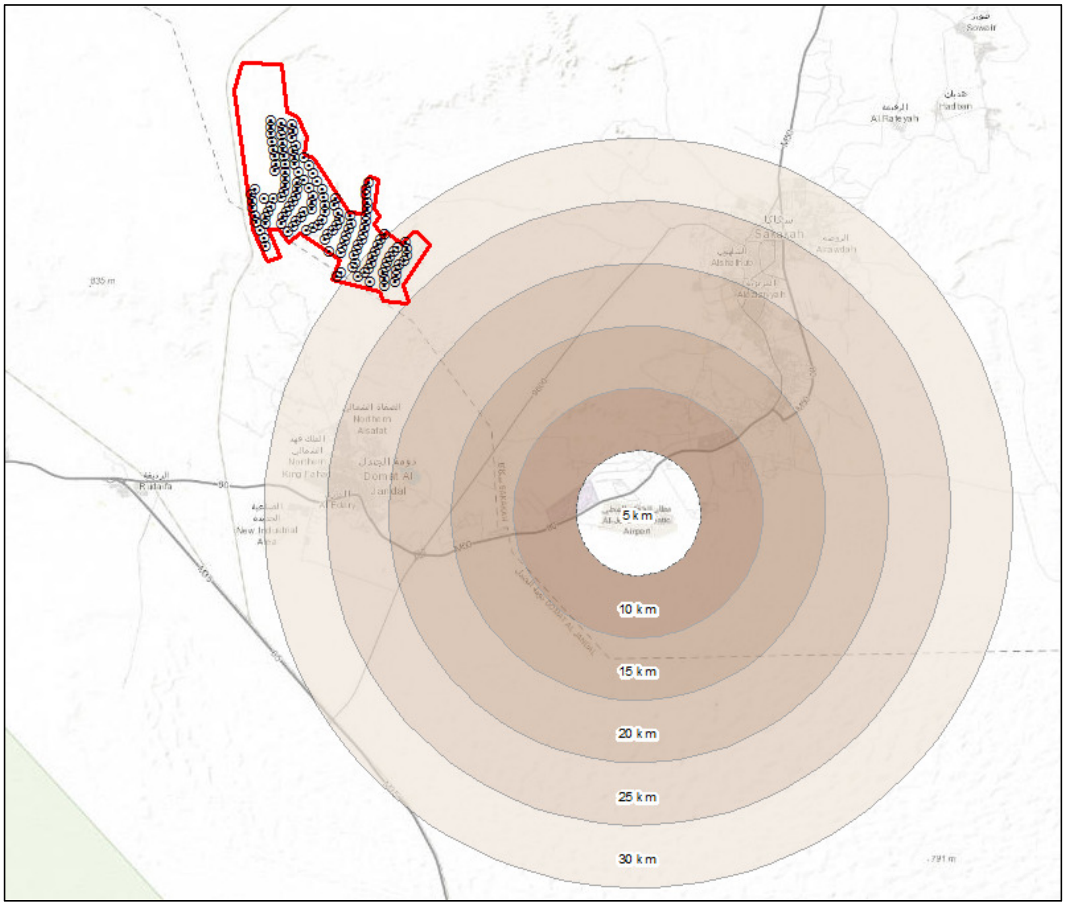
7.1.1 Assessment Methodology

Ministry of Defence Setback distance: During preliminary consultation, the Ministry of Defence requested that a setback distance of 6km be applied to the Al Jouf military base. The Dumat Al Jandal wind energy Park is located approximately 25km from the military base, and on this basis the Ministry of Defence safeguarding zone of 6km is met.

GACA Consultation: As a consequence of identifying that approximately 25 turbines are within the 30km criterion specified in the guidance document *UK Civil Aviation Authority (CAA) Policy and Guidelines on Wind Turbines CAP764* (Figure 7.1) and considered as potentially impacting on civil aerodrome operations, the Renewable Energy Project Development Office initiated consultations with the Kingdom of Saudi Arabia's General Authority for Civil Aviation (GACA).

An Obstacle Evaluation Request form was submitted to GACA based on a turbine height of 225m and in response GACA have issued a letter of No -Objection on the height of 225m above ground level of WTG for the project site as per table provided [3].

Figure 7.1 : Dumat al Jandal wind Energy Park in the 30 km buffer zone of Al Jouf



7.1.2 Potential Impact

As a consequence of identifying that approximately 25 turbines are within the 30km criterion specified in the guidance document *UK Civil Aviation Authority (CAA) Policy and Guidelines on Wind Turbines CAP764*, consultation with the Kingdom of Saudi Arabia's General Authority for Civil Aviation (GACA) was initiated.

In response to receiving the Obstacle Evaluation Request form, GACA have issued a letter of No -Objection on the height of 225m above ground level of WTG for the project site. On this basis, no impact on civil aviation is anticipated.

7.1.3 Recommendation

It is recommended that should the submitted parameters change, GACA should be further consulted.

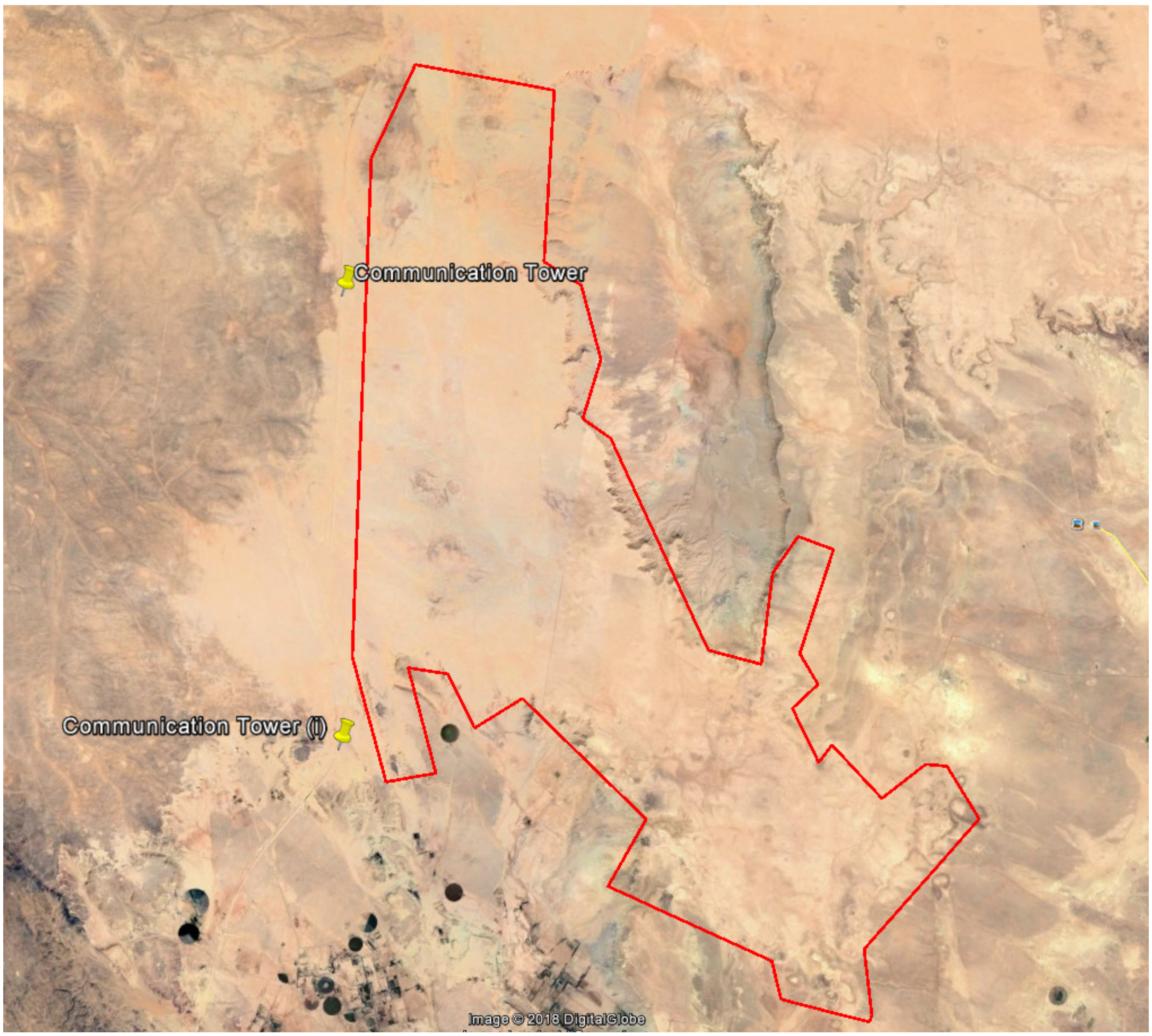
At this stage of the assessment, the Ministry of Defence has not provided any information relating to the type of radar utilized at the base, details of any low flight areas, national air defence infrastructure or air traffic control facilities at the base. It is therefore recommended that further consultation is sought with the Ministry of Defence to ensure the proposed development of Dumat al Jandal wind energy Park will not adversely impact on their radar systems.

7.2 Telecommunications masts

7.2.1 Receptor description

There are two telecommunications towers that have been identified within 1km from the Dumat al Jandal site boundary as shown in in Figure 7.2 below. The CITC consultation held confirmed that these masts do not belong to CITC.

Figure 7.2 : Location of telecommunication towers relative to the Dumat al Jandal site boundary



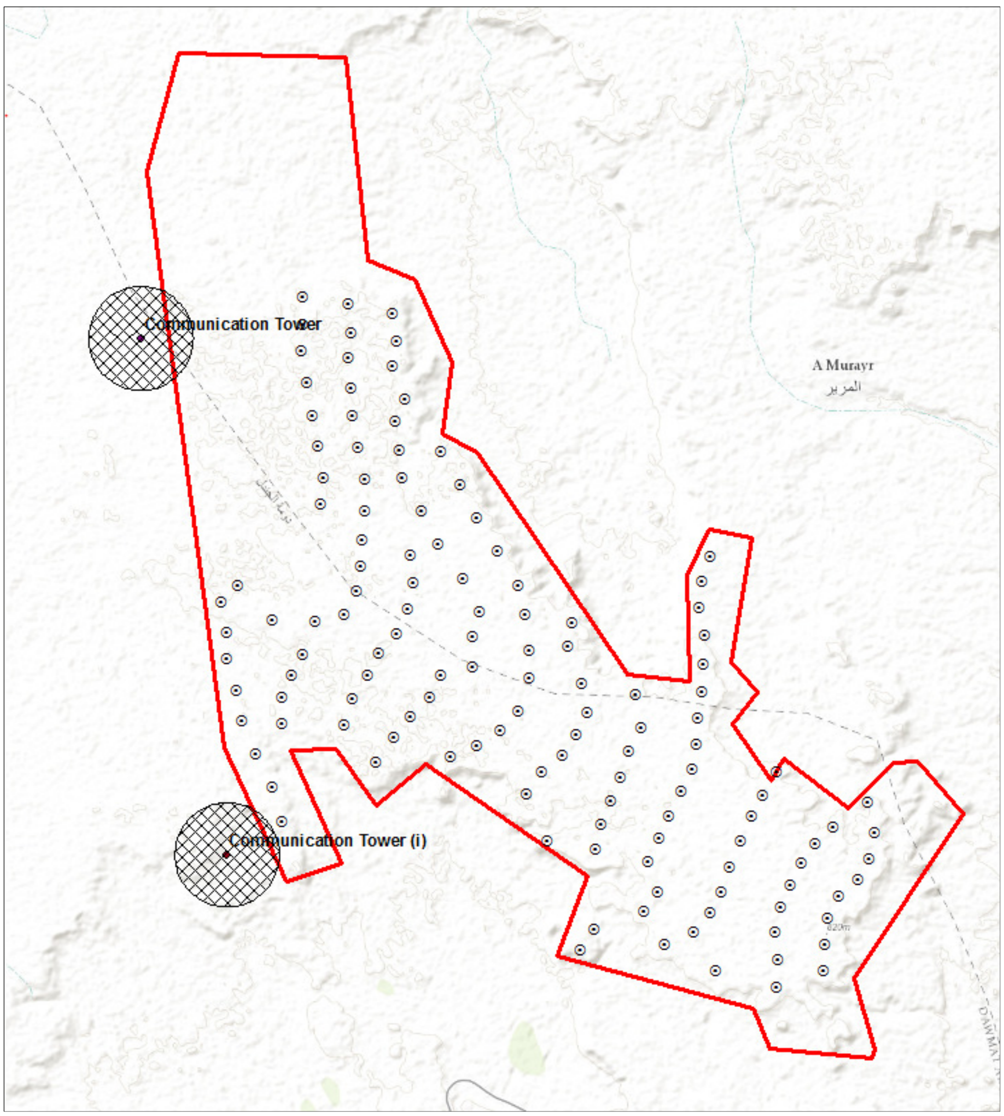
7.2.2 Assessment Methodology

A setback distance of 1km has been applied to the two telecommunications towers. In reality wind turbine induced interference is difficult to predict as the level of interference depends on several factors related to the emitter, the receptor, the wind farm and the propagation environment including:

- Relative position of the emitter, receptor and wind turbines

- Transmit Power (Strength of emitted signal)
- Noise sensitivity of the system
- Bandwidth of the system
- Information transfer rate
- Size of the chosen turbine
- Orientation of blades and rotor
- Rotor rotational speed

Figure 7.3 : 1km buffer of telecom masts relative to the proposed windfarm at the Dumat al Jandal site



7.2.1 Potential impact

No impact has been identified following applying a 1 km buffer radius. This would need to be complemented by information on the receiver /transmitter to establish the Fresnel zone.

7.2.2 Recommendation

It is necessary to consult with stakeholders; owners and operators to agree buffer around telecoms masts.

8. Risk Mitigation

This section summarises the main industry standards and best practice risk mitigation measures that can be adopted by stakeholders at the Dumat al Jandal to reduce potential navigational risk to an acceptable level. The requirement for any specific mitigation is subject to further consultation with key stakeholders, specifically the Ministry of Defence.

Table 8.1 : General Mitigation

Type of Mitigation	Mitigation	Description
Industry Standard	Information circulation	Appropriate liaison to ensure information on the wind farm sites and special activities is circulated in Notices to Mariners, Navigation Information Broadcasts and other appropriate media.
Industry Standard	Marking and lighting	Structures to be marked and lit in-line with maritime and aviation guidance. This has been stated in the letter of No Objection received from GACA
Wind farm design	Consultation	Further consultation with the Ministry of Defense is required to ensure there is no impact to their radar system as instrumentation details were not provided for this assessment. Mitigation might include amendments to the layout of the turbines to avoid areas identified during consultation. It is necessary to consult with the owners and operators of the identified masts to agree buffer around telecoms masts.

8.1 Mitigation Measures

8.1.1 Radar and Navigational related mitigation measures

In areas where wind turbines could have a perceptible impact on radar systems, a limited number of mitigation measures may be available to reduce the effect of wind turbines on radar systems.

- Advanced modelling to verify impact based on stakeholder input and defined turbine characteristics
- Reducing the radar cross section (RCS) by rearranging/relocating the turbines a short distance may also mitigate the impact caused by the wind farm.
- Stipulating in the minimum functional specification the need for turbine blades to have radar absorbing properties.
- Radar absorbing or non-reflective material may also be used as an alternative for building tower/turbine, and may have little or no significant additional costs.

- Advanced filtering of primary radar return signal, cell control (possibly together with above 'in wind farm vertical radar')
- Radar within the wind farm to fill gaps in information

8.1.2 Telecommunications related Mitigation measures

8.1.2.1 Point to point Systems

In areas where wind turbines could have a perceptible impact on a received signal, a number of mitigation measures may be available to reduce or eliminate the effect of wind turbines on such radio communication systems. During the planning stage, the placement of individual wind turbines should take into consideration local microwave. Moving a wind turbine, a short distance may be enough to clear the radio-communication path and eliminate the potential for interference.

Proper care is taken at the wind farm planning stage, radio-communication systems will most likely not be impacted. Prevention and control measures to address impacts to telecommunications systems include the following:

- Modify placement of wind turbines to avoid direct physical interference of point-to-point communication systems
- consultation with relevant operators can assist in establishing the location of telecommunication links and relevant buffers to be applied in order to minimize impacts
- Install a relay next to the wind farm
- Modify the existing aerial
- Install an amplifier to boost the signal
- If degradation is noticed in the operational phase of the project, there are a number of mitigation methods available. These include:
- replacing the receive antenna with one that has a better discrimination to the unwanted signals,
- relocating either the transmitter or receiver, or
- switching to an alternate means of receiving the information (fibre-optics or other means).

9. Conclusion

The preliminary radar and communication assessment for Dumat al Jandal wind energy Park has not identified any significant adverse impacts, based on the consultations completed to date and the information provided by key stakeholders. However, further consultations and analysis are recommended to guide the development of the wind energy development and to avoid major impact on identified receptors.

Additional detailed information will be required to assess specific mitigation measures and continue discussions with stakeholders, this includes information about point to point communication from identified telecommunication towers and the details of the radar system utilized at the Al Jouf military base.

It is concluded that:

- There is likely to be minimal to no negative impact to the Al Jouf airport civil aviation operations by the proposed development based on the letter of No Objection provided by GACA after an obstacle evaluation request form was requested and carried out by GACA.

- The Dumat al Jandal wind energy Park falls outside of the 6km safeguarding zone requested by the Ministry of Defence. On this basis, no significant impacts are predicted. However, it is recommended that further consultations are held with the Ministry of Defence and further analysis is undertaken to determine that the Park will not adversely impact on the radar systems of the military base.

- Using the EUROCONTROL guideline, and based on its distance to the airport, Dumat al Jandal will fall within the Zone 3 or 4, should the radar at Al jouf be a Primary Surveillance Radar (PSR). This will mean that a simple assessment would be required, should it be established that the proposed Park is within maximum instrumented range and in radar line of sight.

- If the radar is a SSR (classical, monopulse and Mode S), the impact of the wind turbine should be considered to be tolerable. [4] as the proposed Park is further than 16km.

- The standard 1 km setback distance has been used and this has shown no significant impact on telecommunication facilities. However, it is recommended that further analysis is undertaken to determine the Fresnel zones of associated microwave paths and ensure the location of individual wind turbines in the Park do not compromise telecommunication signals (point-to-point).

Table 9.1 : Summary of Radar and Communications receptors and potential impacts at Dumat al Jandal

Id	Receptor	Classification	Stakeholder	Potential Impact	Potential Mitigation
1.	Al Jouf airport	Airport – Civil and Military	GACA / Ministry of Defence	Consultation with GACA for obstacle evaluation has resulted in a letter of No Objection being issued for the turbine height of 225m. Ministry of Defense radar facility	None required except substantial changes are made to the coordinates submitted to GACA. Further consultation with the Ministry of Defense is required to ensure that there is no impact to their radar system as instrumentation details were not provided for this assessment.

Id	Receptor	Classification	Stakeholder	Potential Impact	Potential Mitigation
2.	Communication Masts		Unknown	Using just the setback distance of 1km, it does not appear that the turbines will impact the telecoms tower.	It is necessary to consult with stakeholders; owners and operators to agree buffer around telecoms masts and identify Fresnel zone clearance if required resulting in possibly some local adjustment of a number of turbines within the Park area. Further, re-routing of microwave paths might have to be considered.

10. References

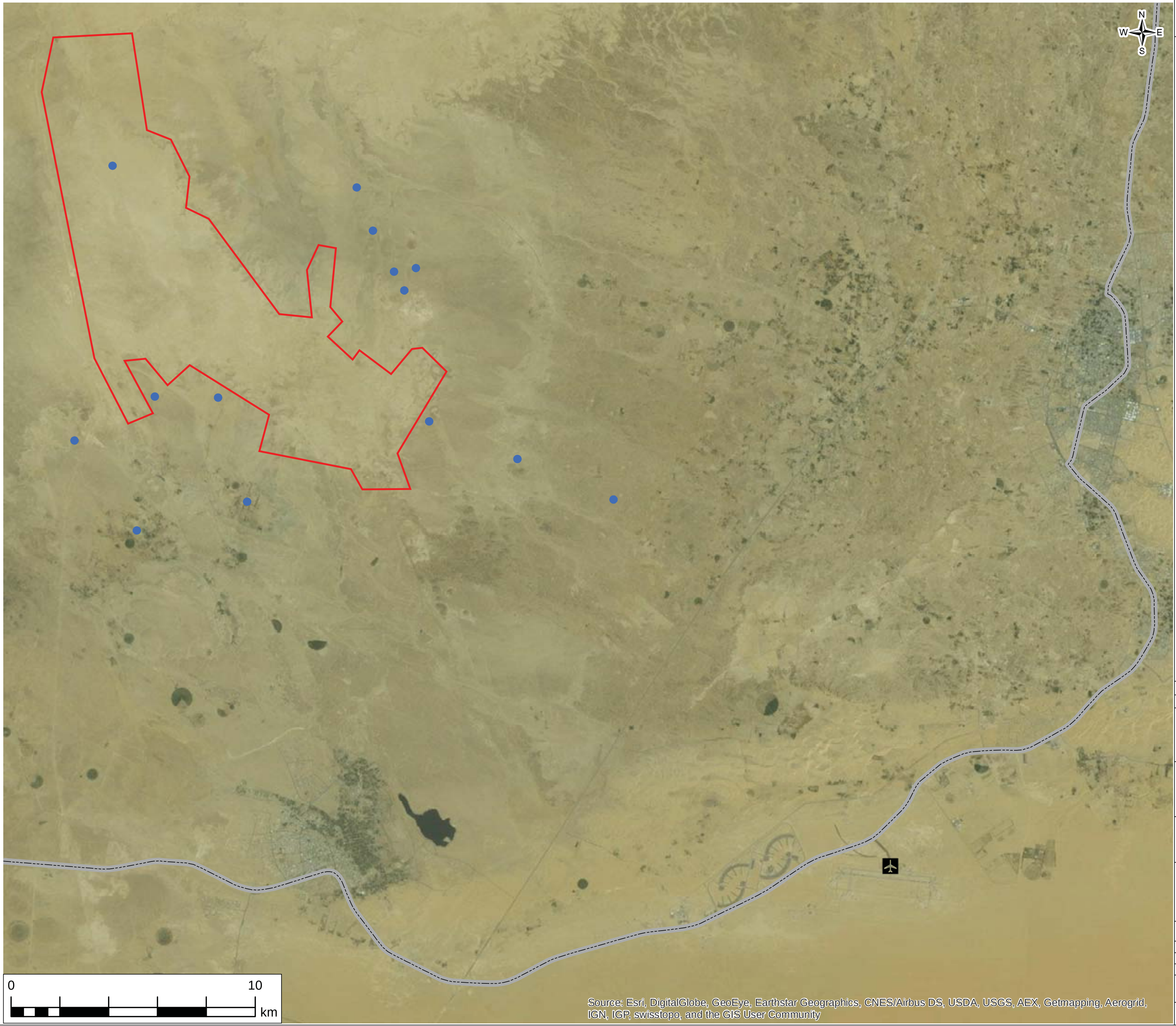
1. DNV GL – Report No. 14-008 ME-R-16,Issue A- Preliminary Design Assessment for Dumat al Jandal Aramco Overseas Company B.V. dated 08 May 2017

2. QinetiQ and MCA, 2004; MCA, 2005; Marico Marine, 2007

3. GACA No Objection Letter 225m high WTG.pdf

4. EUROCONTROL Guidelines ‘ How to Assess the Potential Impact of Wind Turbines Surveillance Sensors http://www.eurocontrol.int/sites/default/files/publication/files/20140909-impact-wind-turbines-sur-sensors-guid-v1.2.pdf

Appendix L. All Figures



SA217900-DMT-G-PLN-AQ03

Legend

- Site Boundary
- Road 80
- Al Jouf International Airport
- Air Quality Receptor

Note: Refer to report for references

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

JACOBS ZATE

Client

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

AIR QUALITY RECEPTORS

Drawing Status

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Client No.		
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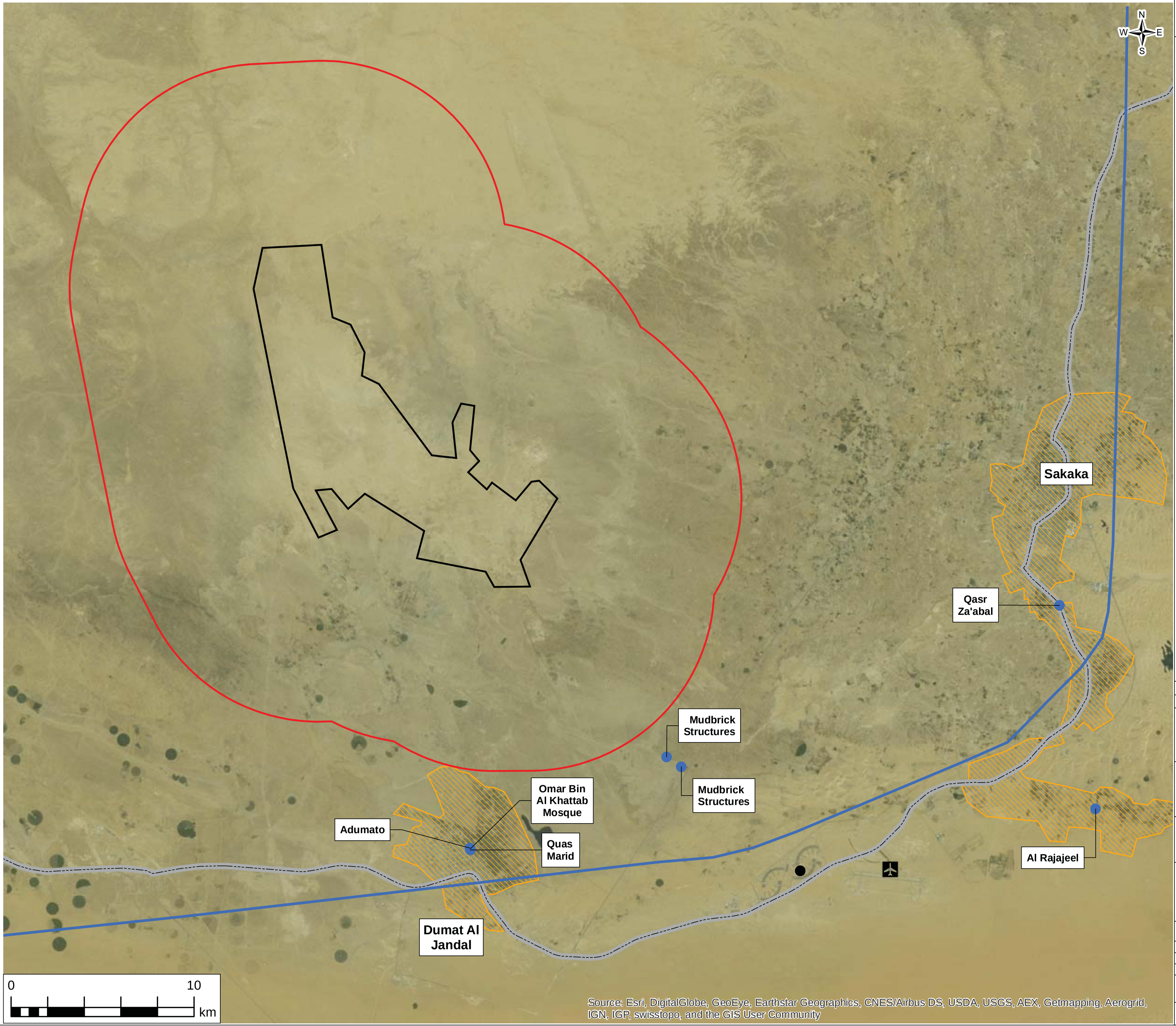

SA217900-DMT-G-PLN-AR03

Legend

- Site Boundary
- 10km Study Area
- Cultural Heritage Assets
- Al Jouf International Airport
- Al Jouf University
- Route 80
- Asset 1 - Zubayas Road (Approximate Route)
- Settlement

Note: Refer to report for references

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JAN 17	Initial Issue	IM	AD	AD	MR

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saudi aramco

Project

DUMAT AL JANDAL WIND
ENERGY PARK

Drawing Title

SITES OF TANGIBLE ARCHAEOLOGICAL
AND CULTURAL HERITAGE

Drawing Status

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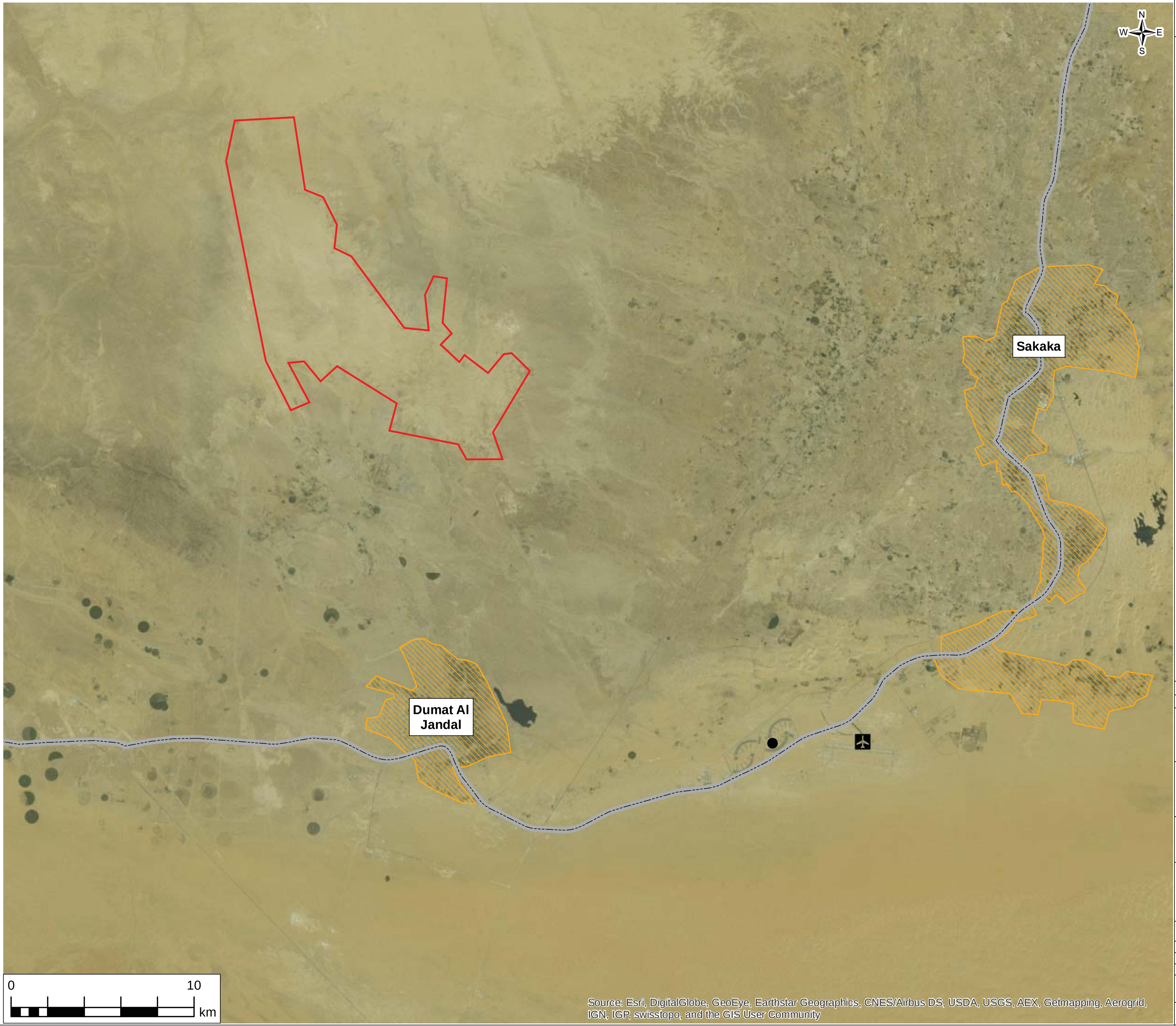

SA217900-DMT-G-PLN-GE03

Legend

- Site Boundary
- Al Jouf Internationl Airport
- Al Jouf University
- Road 80
- Settlement

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JAN 17	Initial Issue	IM	AD	AD	MR

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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

SITE LOCATION PLAN

Drawing Status

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Client No.		
Drawing No.	SA217900-DMT-G-PLN-GE03	

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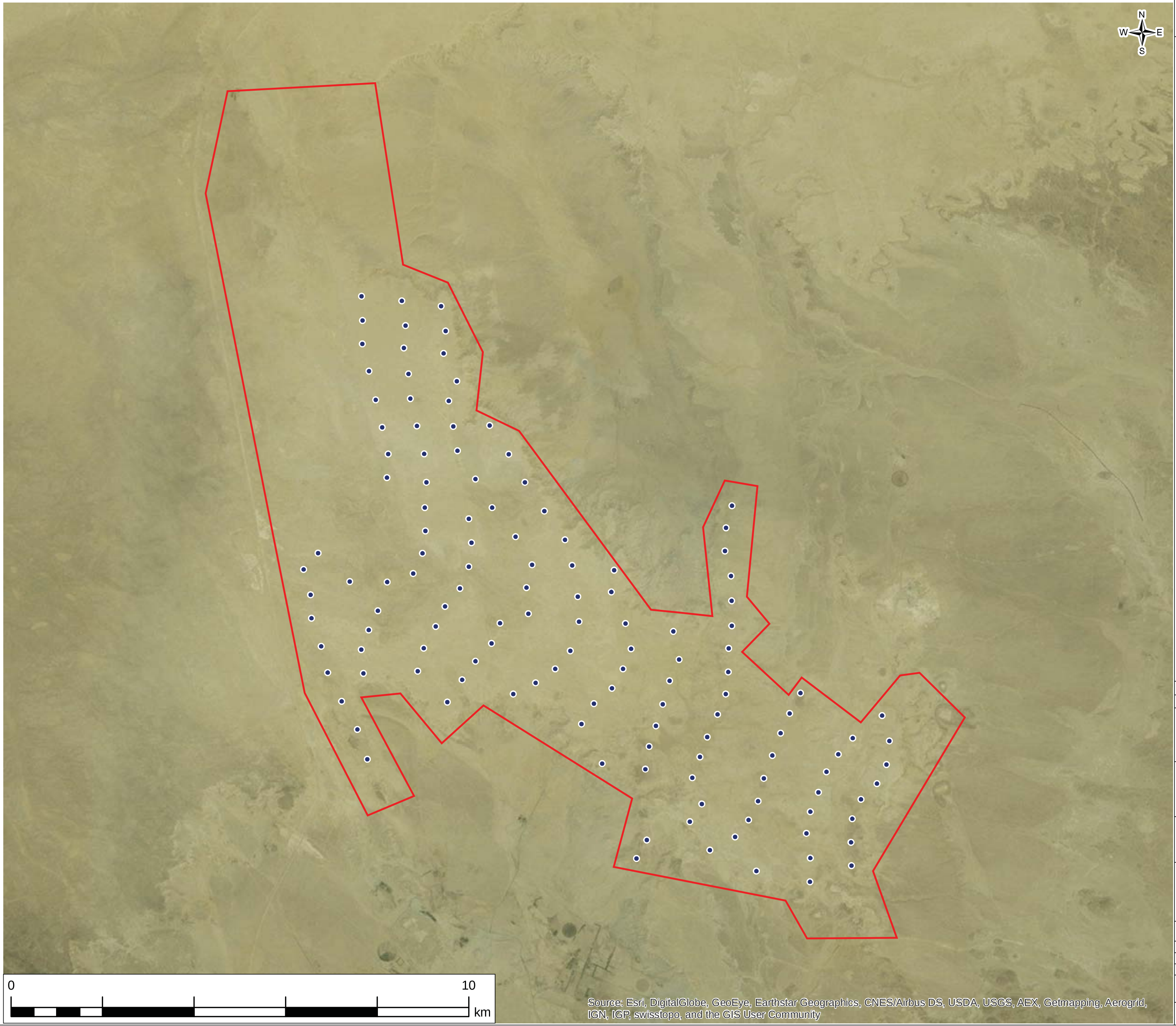
SA217900-DMT-G-PLN-GE06



Legend

- Site Boundary
- Indicative Turbine Layout

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

SITE LAYOUT

Drawing Status

Scale @ A3	1:80,000	DO NOT SCALE
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Client No.		
Drawing No.	SA217900-DMT-G-PLN-GE06	

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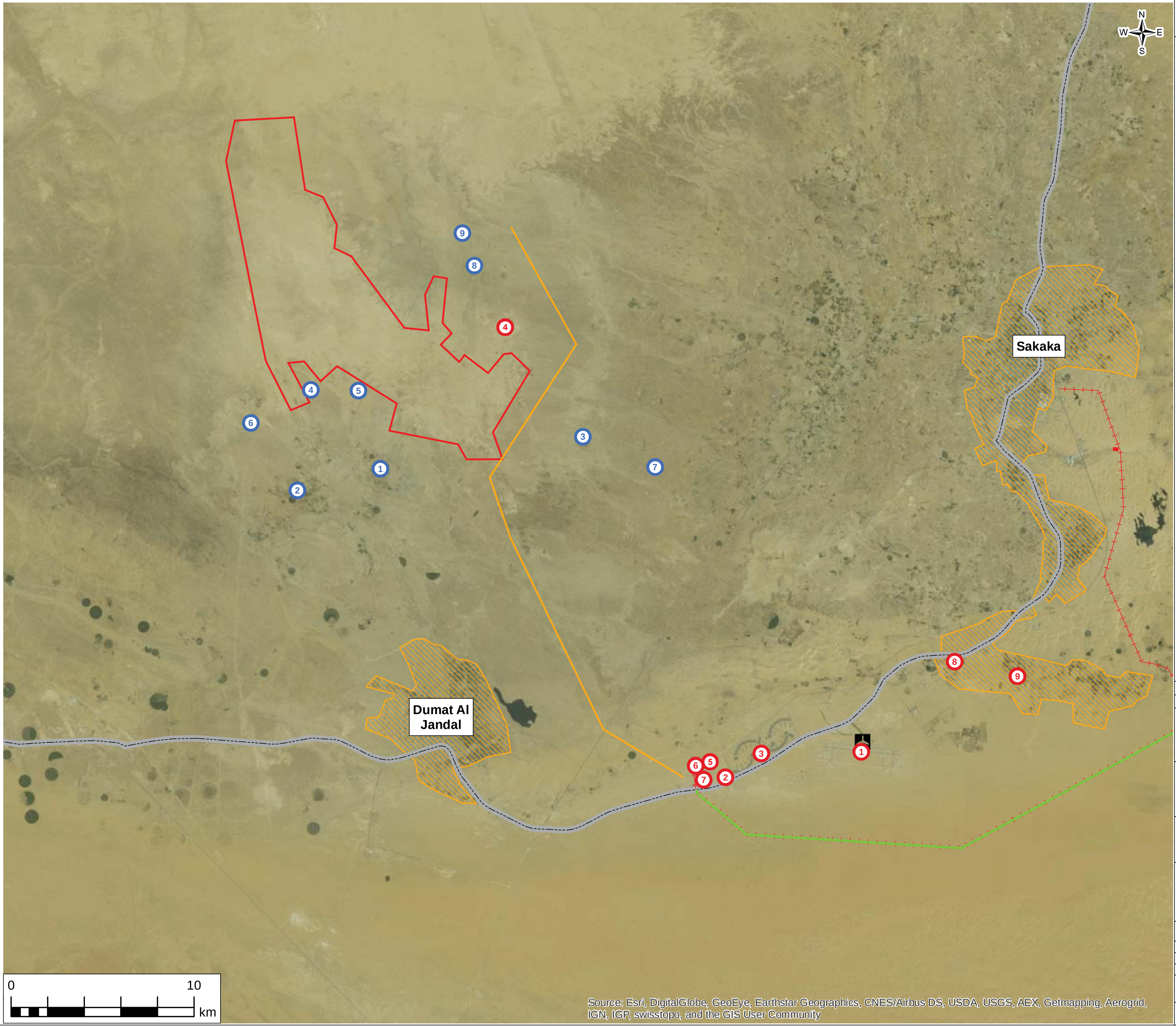

SA217900-DMT-G-PLN-GE09

Legend

- Site Boundary
- Road 80
- Settlement
- Al Jouf International Airport
- Human Receptors (Seasonal Herders / Farms)
- Human Receptors (Towns)
- Infrastructure and Transportation
- Line Service Road
- Existing 132kV line
- Existing 380kV line
- Al Jouf SS PP

Note: Refer to report for references

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JAN 17	Initial Issue	IM	AD	AD	MR

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Client: أرامكو السعودية saudi aramco

Project: DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title: RECEPTOR PLAN

Drawing Status

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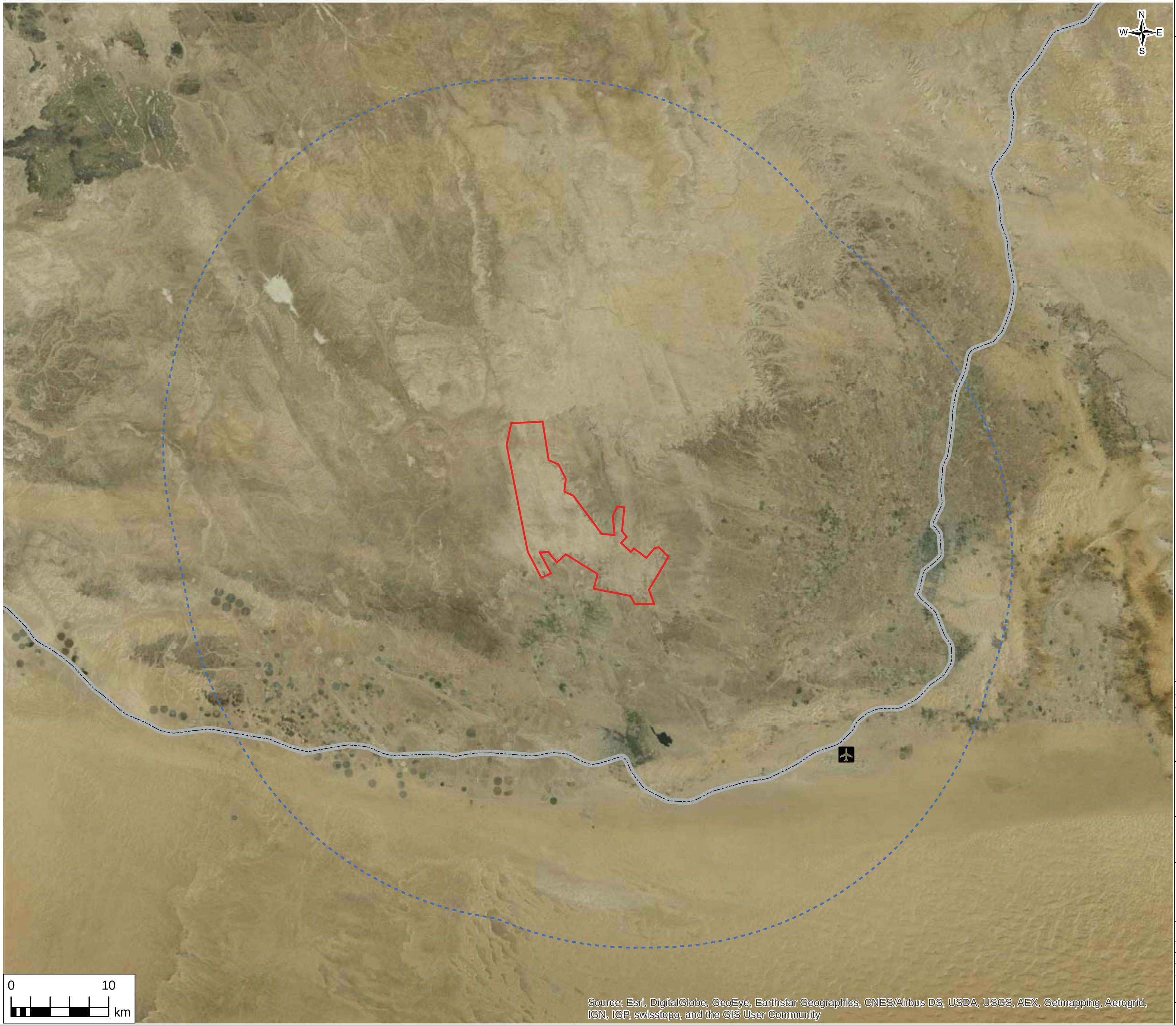

SA217900-DMT-G-PLN-LA03

Legend

- Site Boundary
- 35km Study Area
- Al Jouf International Airport
- Road 80

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JAN 17	Initial Issue	IM	AD	AD	MR

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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

LANDSCAPE STUDY AREA

Drawing Status

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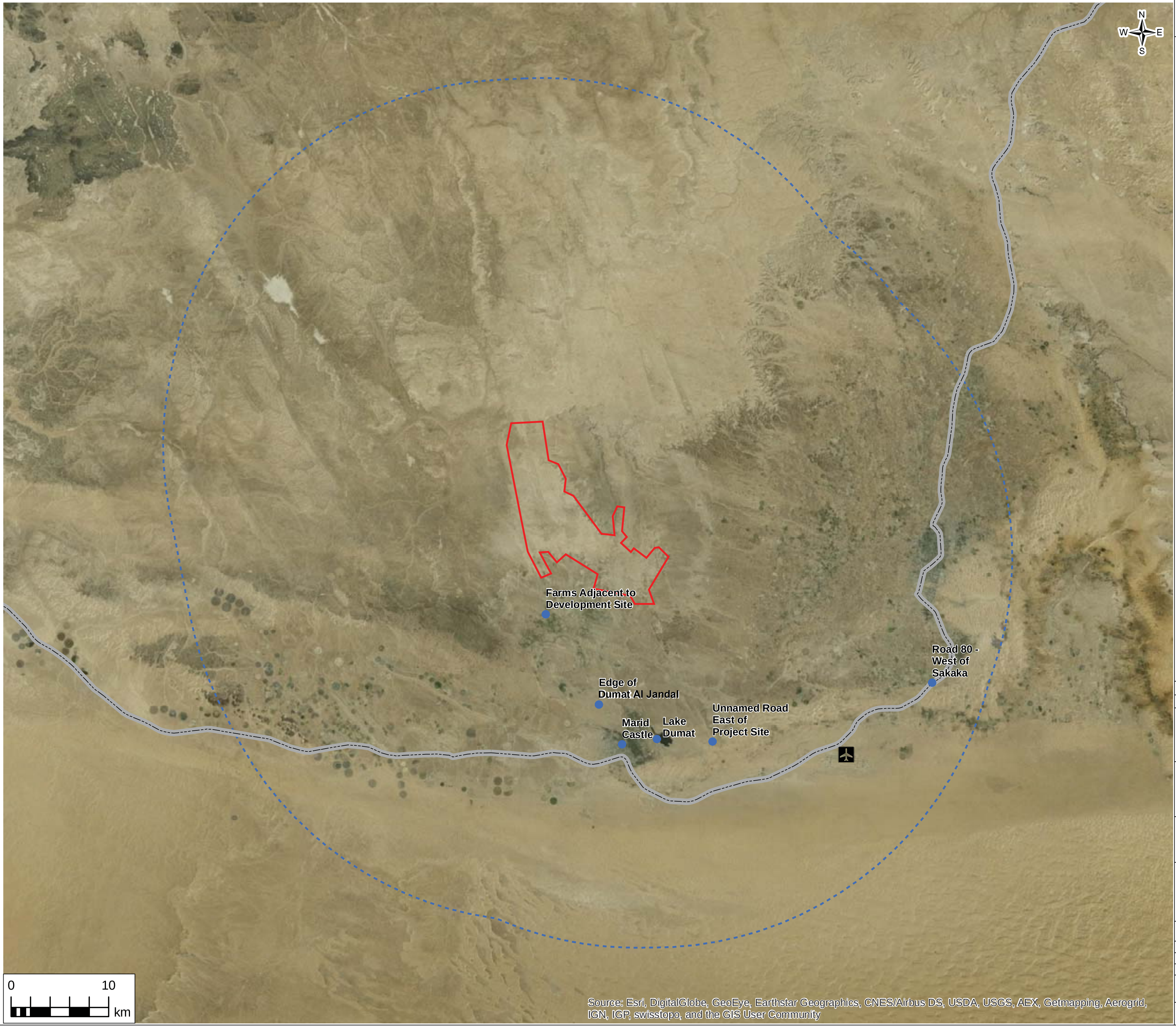

SA217900-DMT-G-PLN-LA06

Legend

- Site Boundary
- 35km Study Area
- Road 80
- Viewpoint Location
- Al Jouf International Airport

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JAN 17	Initial Issue	IM	AD	AD	MR

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DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

LANDSCAPE VIEWPOINTS LOCATIONS

Drawing Status

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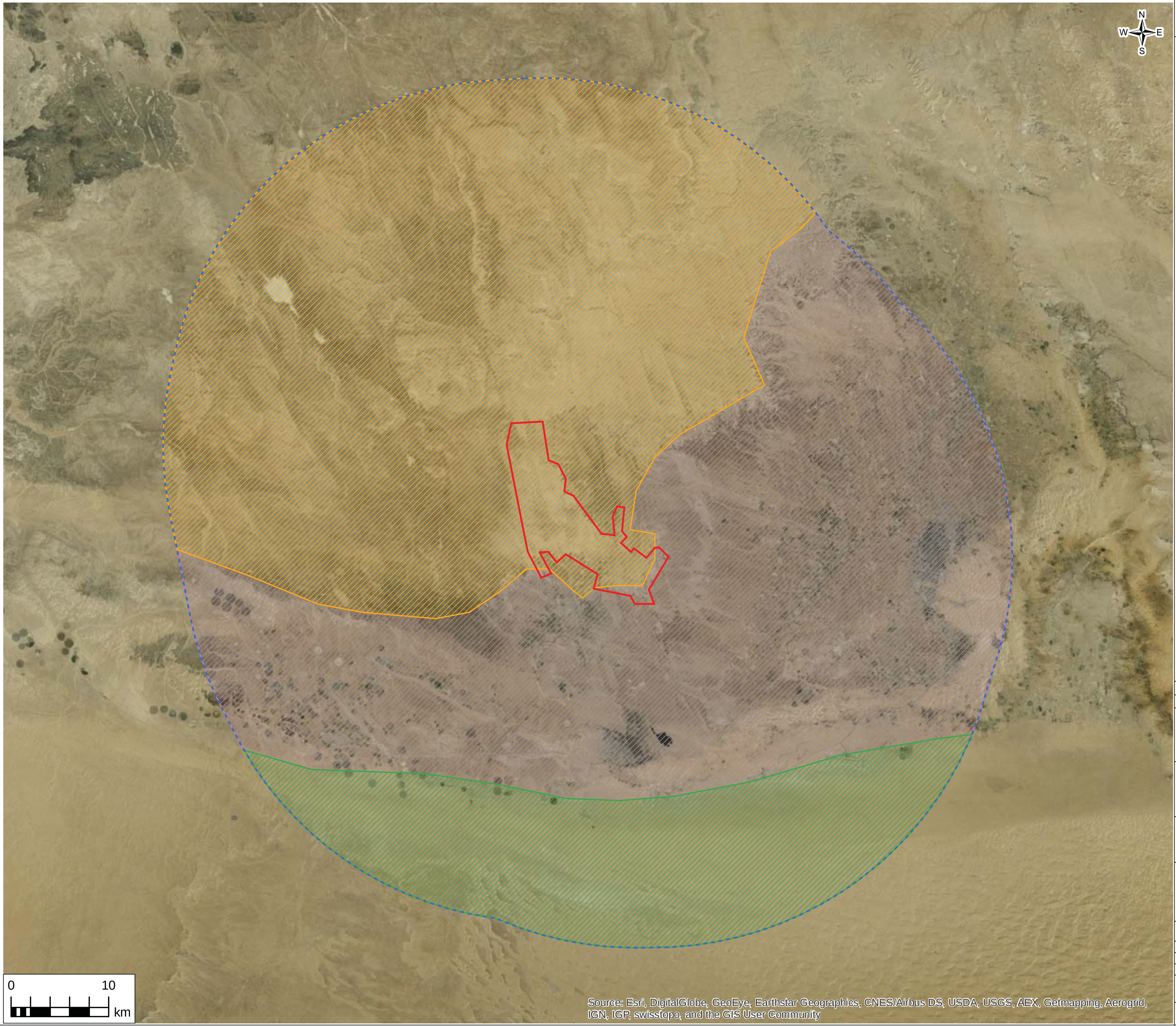

SA217900-DMT-G-PLN-LA12

Legend

- Site Boundary
- 35km Study Area

Landscape Character Areas

- Desert Plain
- Settled Desert Plain
- Desert Plateau

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JAN 17	Initial Issue	IM	AD	AD	MR

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

LANDSCAPE CHARACTER TYPES

Drawing Status

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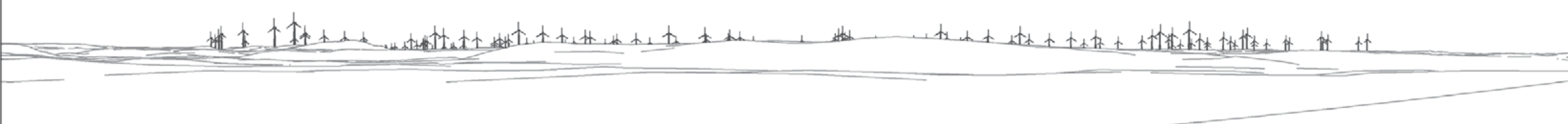
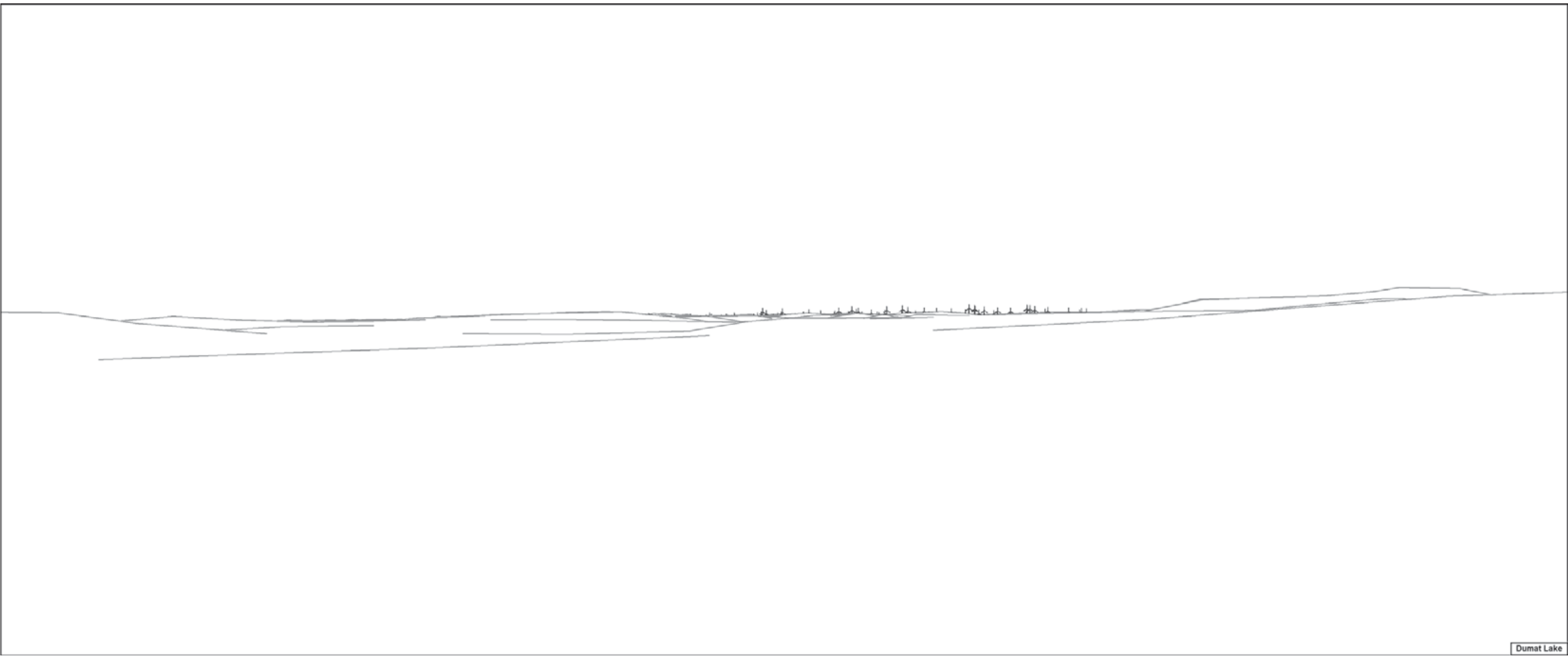
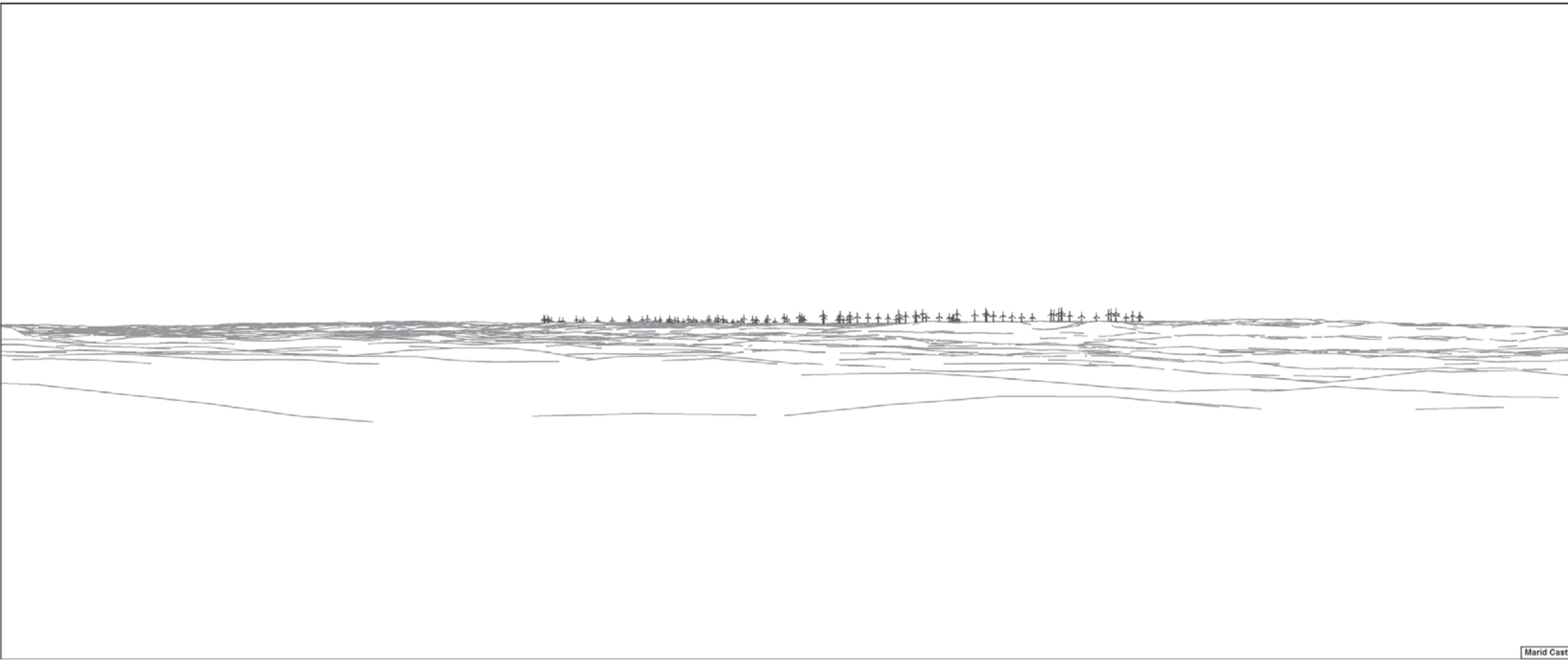
Client No.		
Drawing No.	SA217900-DMT-G-PLN-LA12	

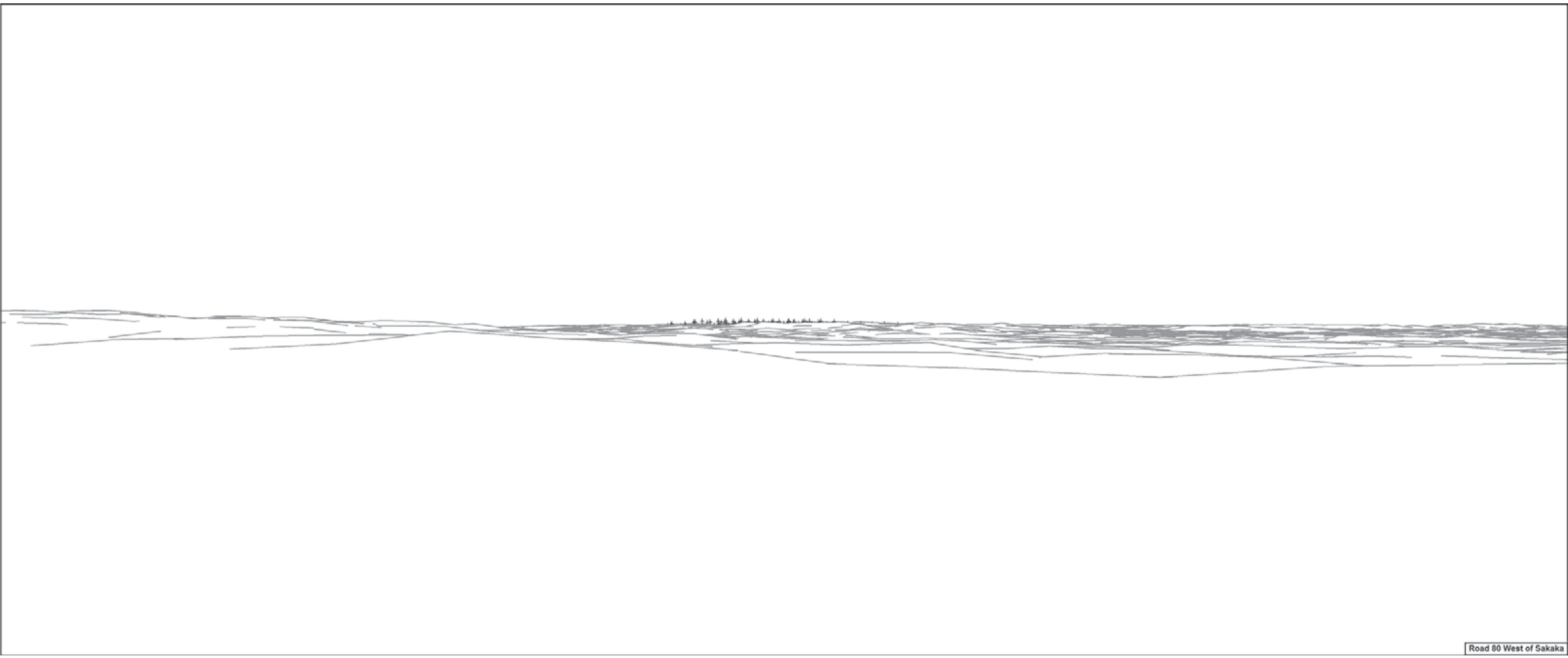

Edge of Dumat



Farms Adjacent to Development Site

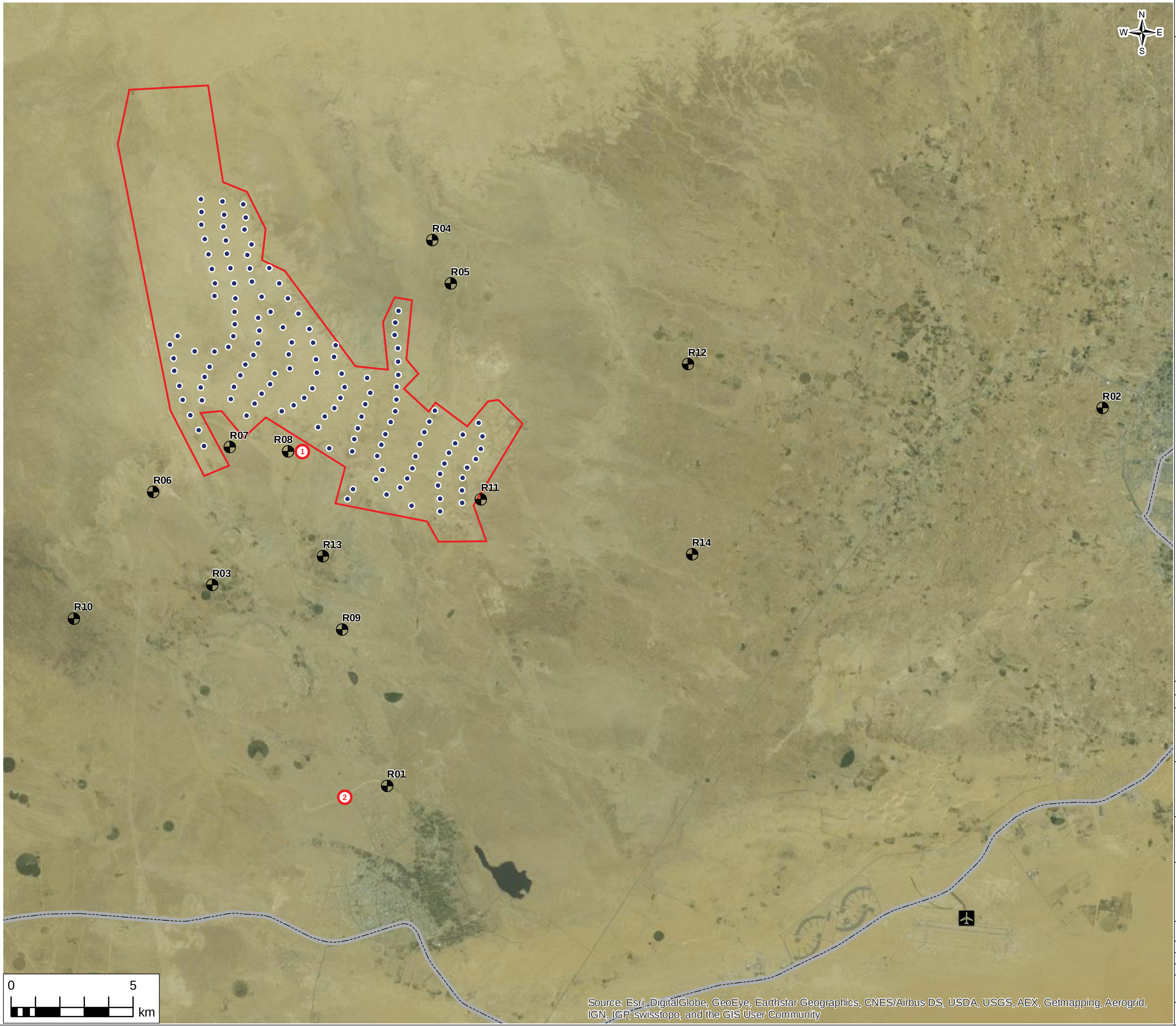

Dumat Lake


Marid Castle


Road 80 West of Sakaka


Unnamed Road

SA217900-DMT-G-PLN-NO03



Legend

- Site Boundary
- Road 80
- Indicative Turbine Layout
- Noise Receptor
- Monitoring Survey Points
- Al Jouf International Airport

Note: Refer to report for references

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

JACOBS ZATE

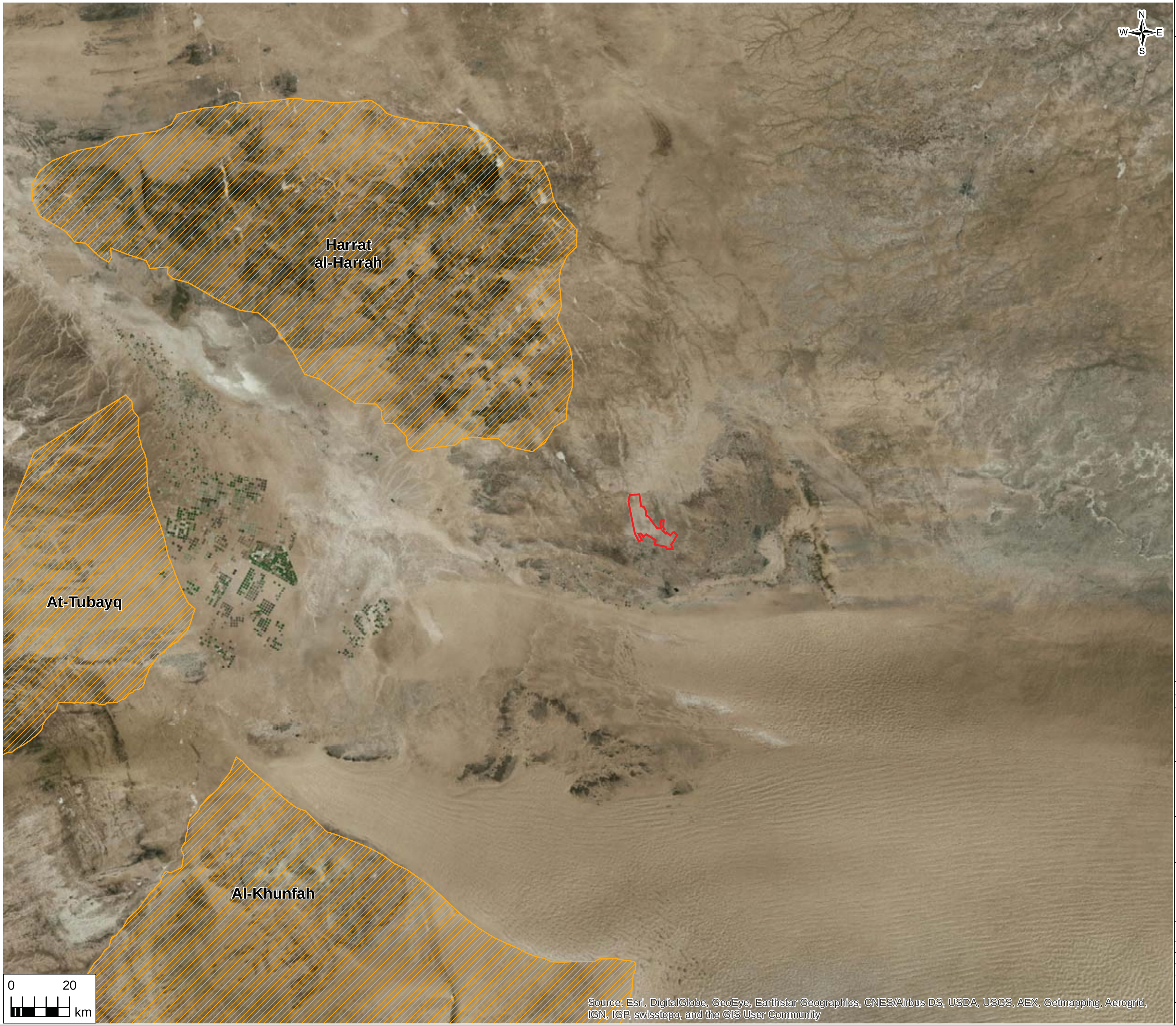
Client: أرامكو السعودية saudi aramco

Project: DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title: NOISE RECEPTOR AND SURVEY LOCATIONS

Drawing Status

Scale @ A3	1:150,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-NO03	



SA217900-DMT-G-PLN-TB03

Legend

- Site Boundary
- International Union for Nature Conservation Protected Areas

0	JAN 17	Initial Issue	IM	AD	AD	MR
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

JACOBS ZATE

Client

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saudi aramco

Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

INTERNATIONAL LEVEL PROTECTED AREAS

Drawing Status

Scale @ A3	1:1,250,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB03	

SA217900-DMT-G-PLN-TB06

Legend

- Site Boundary
- Existing Protected Areas
- Proposed Protected Areas

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JAN 17	Initial Issue	IM	AD	AD	MR

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Client

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Project

DUMAT AL JANDAL WIND ENERGY PARK

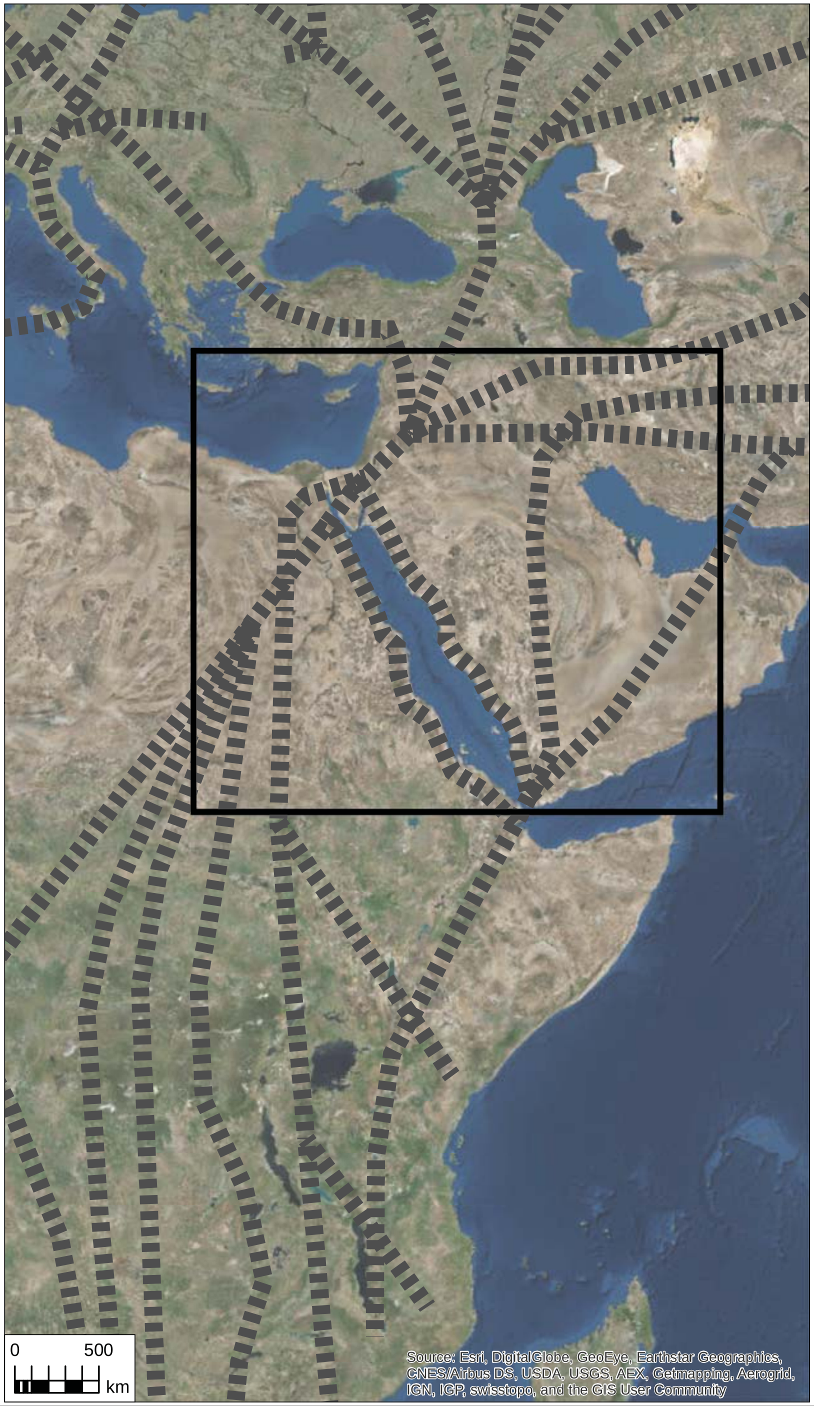
Drawing Title

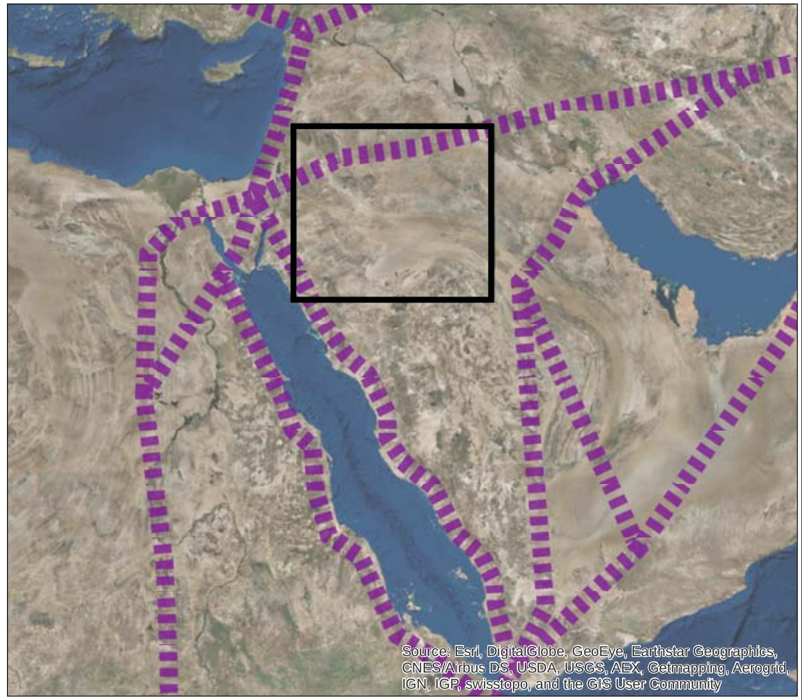
NATIONAL LEVEL PROTECTED AREAS (DESIGNATED AND PROPOSED)

Drawing Status

Scale @ A3	1:1,250,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB06	

SA217900-DMT-G-PLN-TB27





Legend

- Site Boundary
- Indicative Migration Routes between Eurasia and Africa
- Indicative Migration Routes in the Middle East
- Indicative Migration Routes surrounding Sakaka (Red Sea / Rift Valley Flyway)

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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Project

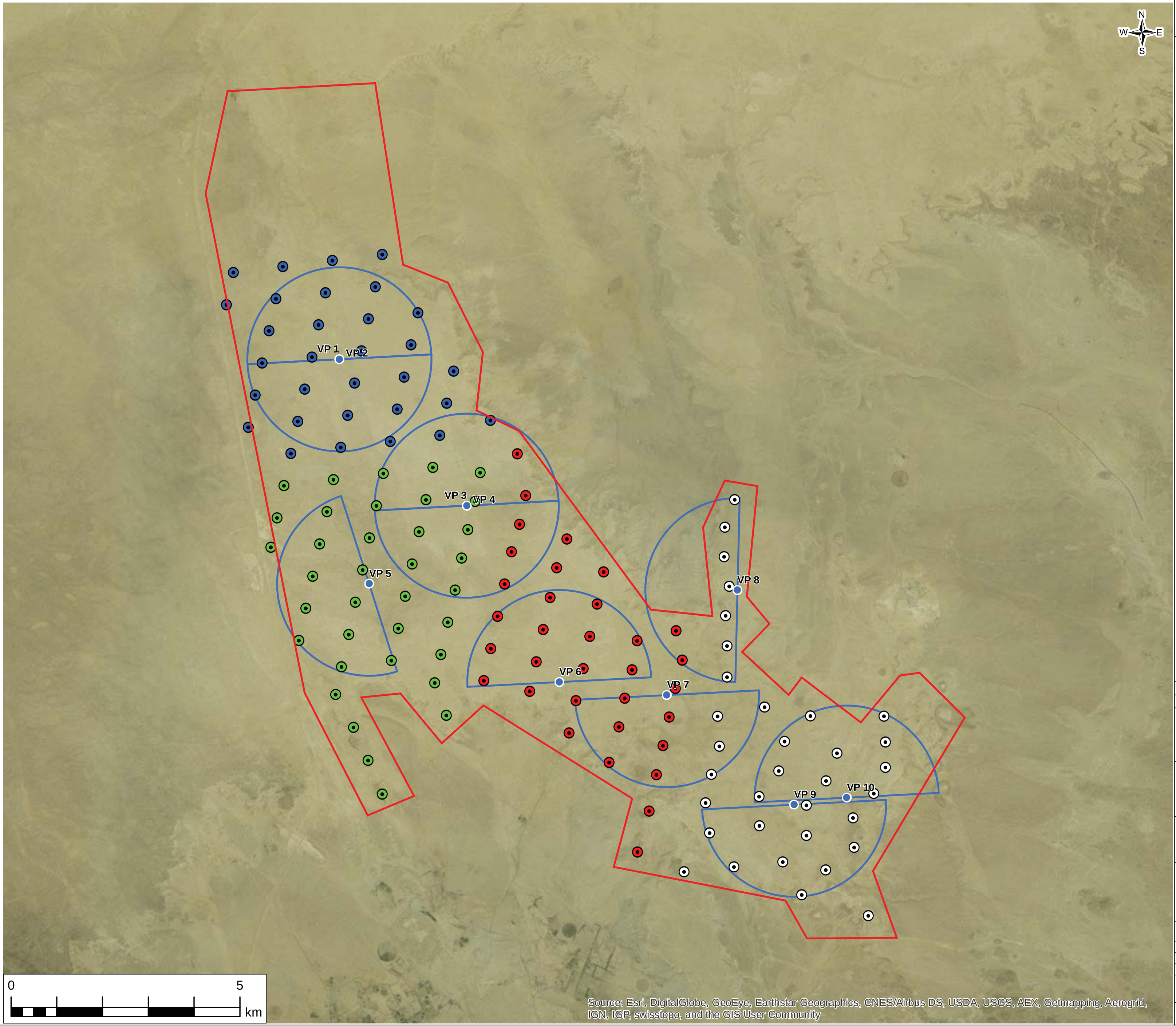
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

INDICATIVE BIRD MIGRATION ROUTES

Drawing Status

Scale @ A3	1:30,000,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB27	



SA217900-DMT-G-PLN-TB09

Legend

- Site Boundary
- Viewpoint Arc

Viewpoints

- VP 1 - 576379.70557, 3325495.32933
- VP 2 - 576379.70557, 3325495.32933
- VP 3 - 578973.30394, 3322174.18417
- VP 4 - 578973.30394, 3322174.18417
- VP 5 - 576767.40021, 3320591.75296
- VP 6 - 580781.6906, 3318240.95766
- VP 7 - 583101.76478, 3317835.56604
- VP 8 - 584751.40716, 3320032.15356
- VP 9 - 585734.37307, 3315312.77476
- VP 10 - 586886.80721, 3315405.84971

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JAN 17	Initial Issue	IM	AD	AD	MR

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Project

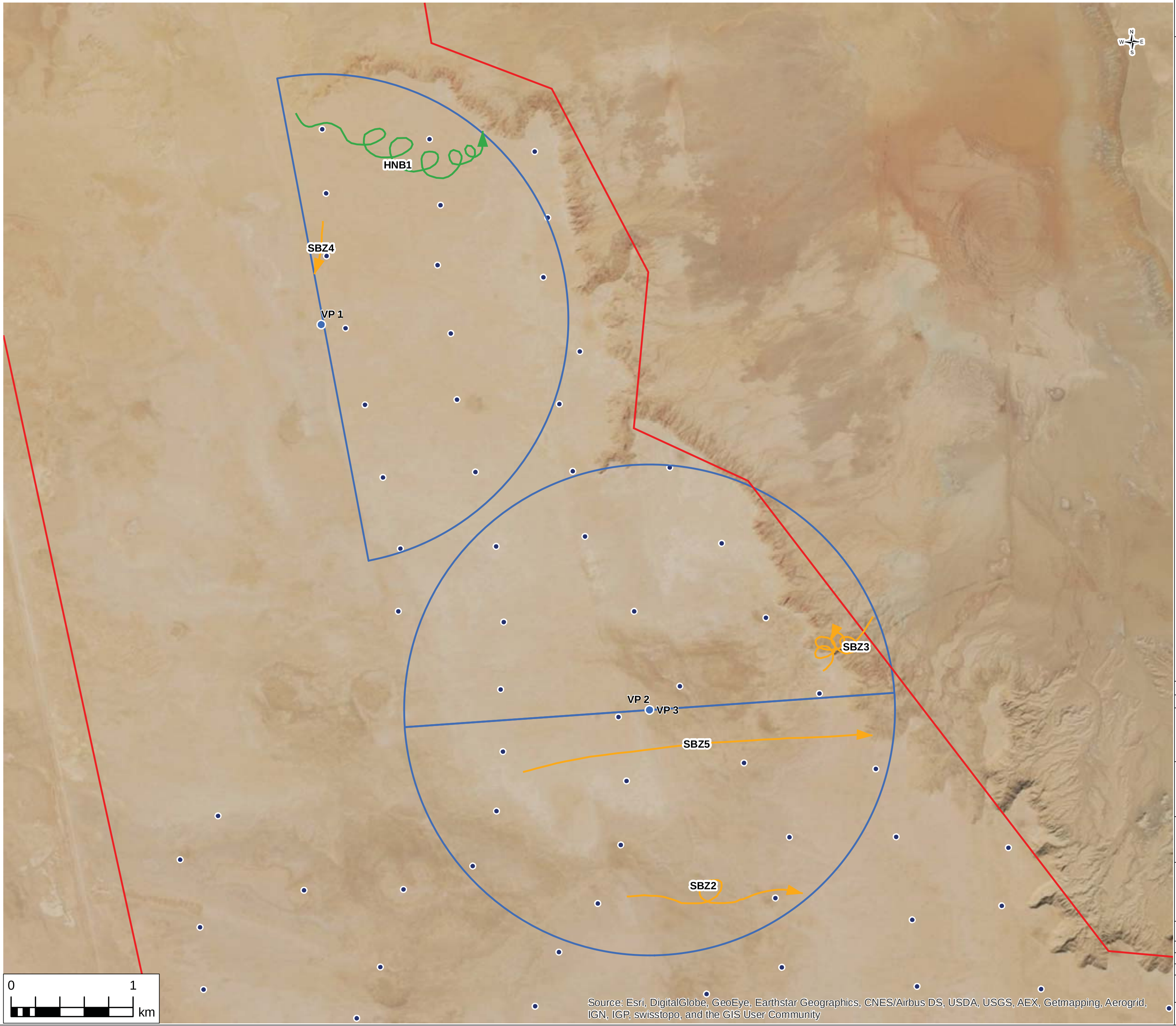
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

MIGRATORY BIRD VANTAGE POINT SURVEY LOCATIONS

Drawing Status

Scale @ A3	1:80,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB09	



SA217900-DMT-G-PLN-TB18-01

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Honey Buzzard
- Steppe Buzzard

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Client

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

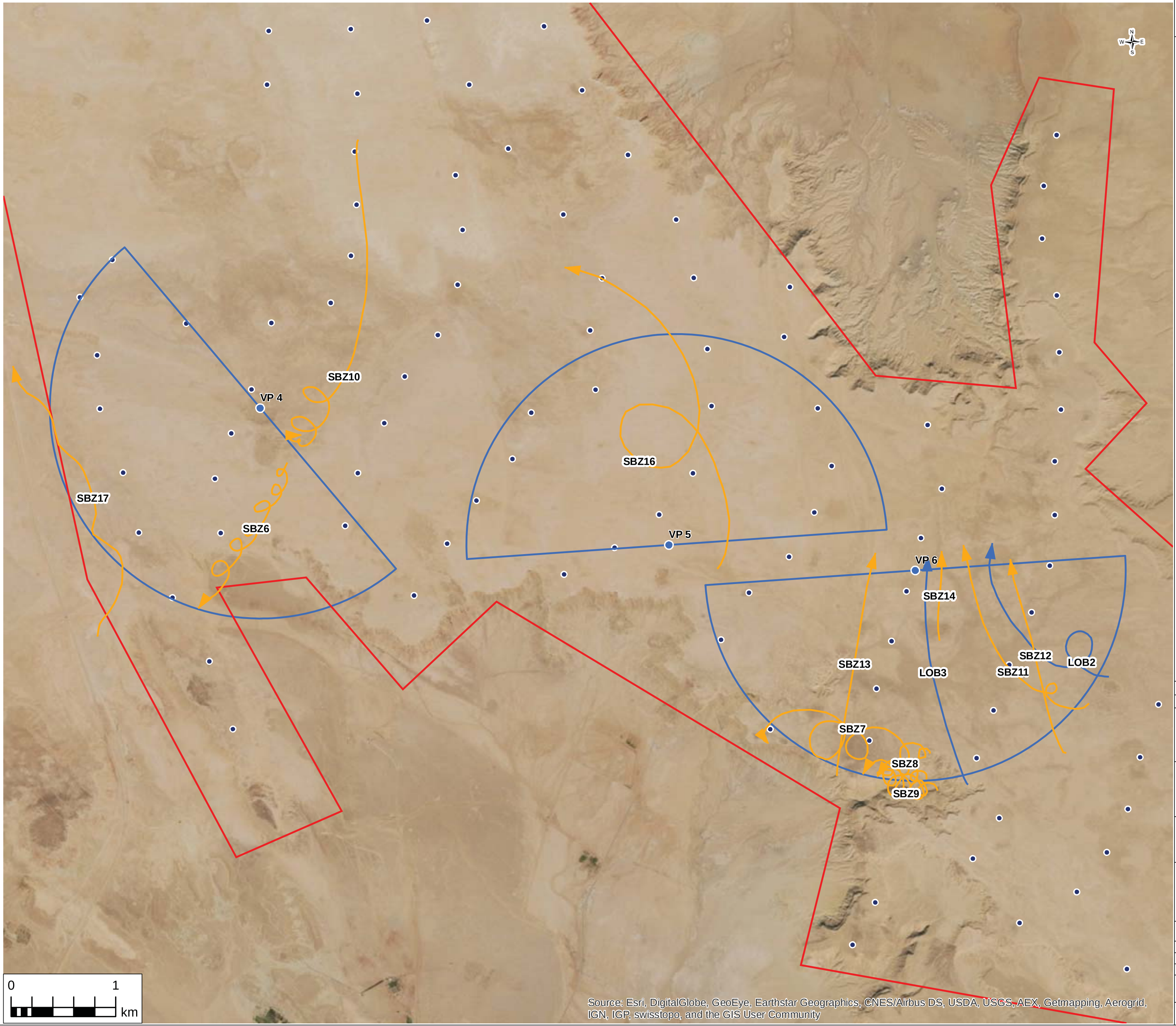
BUZZARD SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-01	

This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.

SA217900-DMT-G-PLN-TB18-02



Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Long-legged Buzzard
- Steppe Buzzard

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Client

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Project

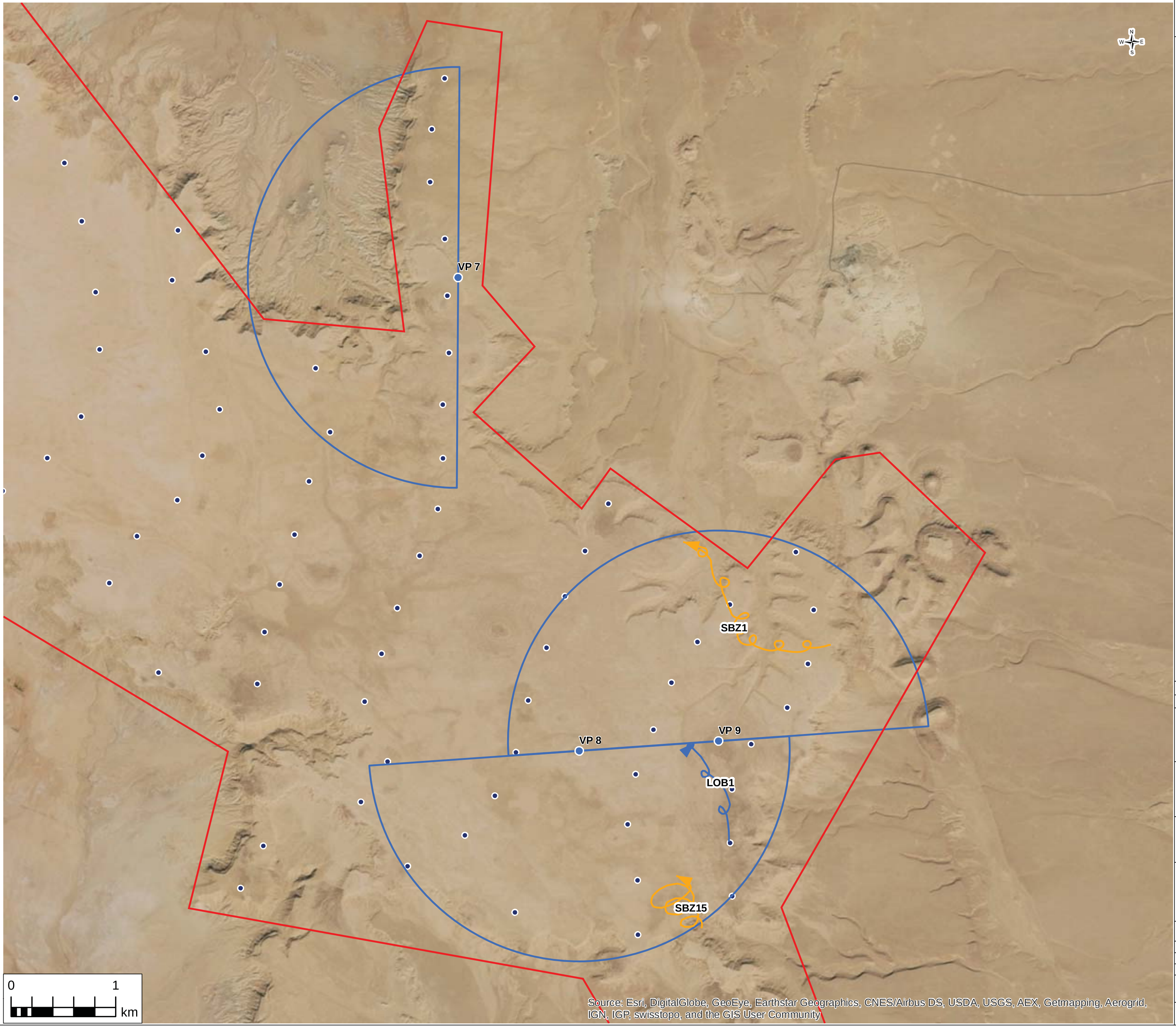
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

BUZZARD SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-02	



SA217900-DMT-G-PLN-TB18-03

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Long-legged Buzzard
- Steppe Buzzard

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Client

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Project

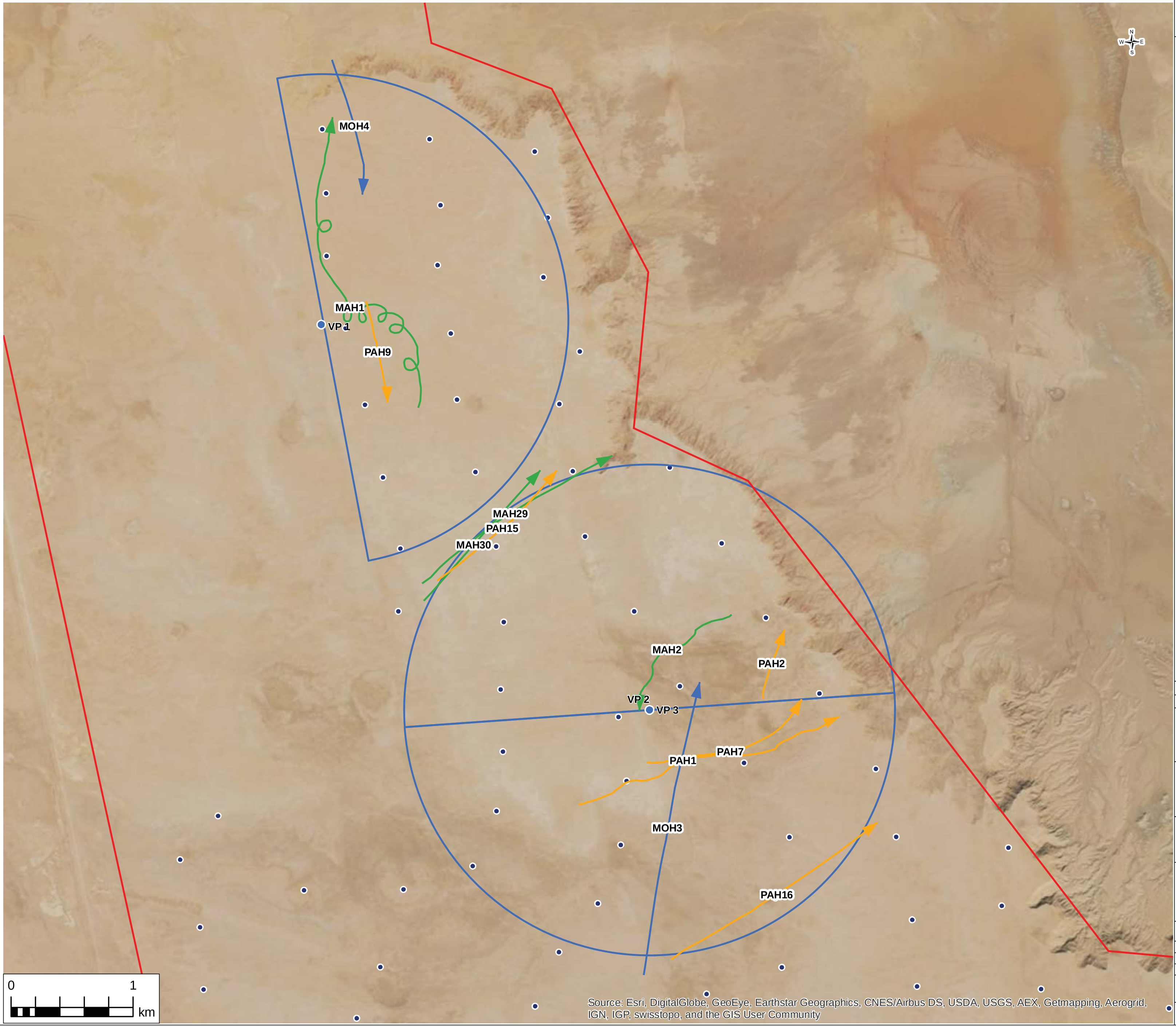
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

BUZZARD SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-03	



SA217900-DMT-G-PLN-TB18-04

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Pallid Harrier
- Montagu's Harrier
- Marsh Harrier

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Project

DUMAT AL JANDAL WIND ENERGY PARK

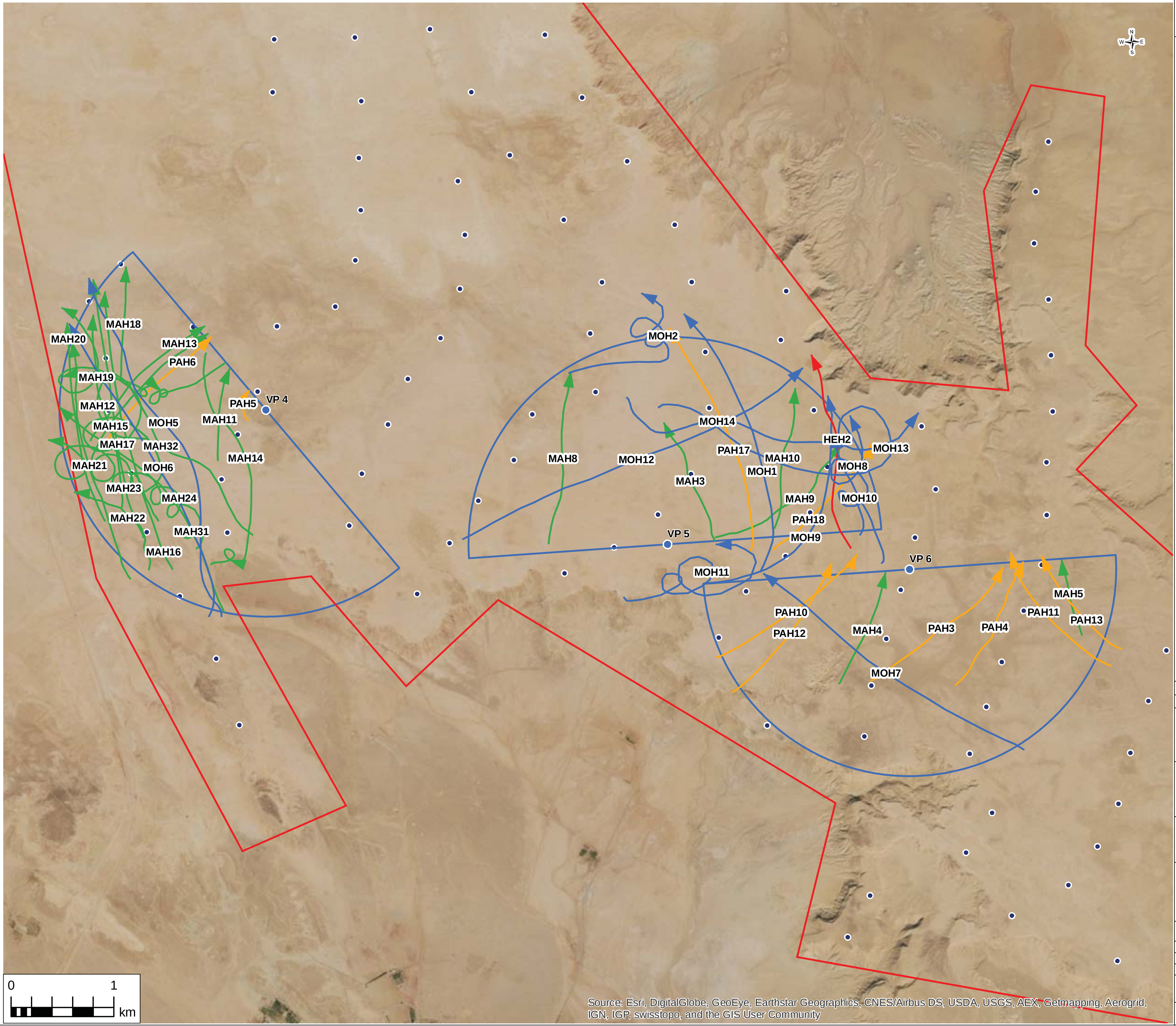
Drawing Title

HARRIER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-04	

SA217900-DMT-G-PLN-TB18-05



Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Pallid Harrier
- Montagu's Harrier
- Marsh Harrier
- Hen Harrier

0	JUN 17	Initial Issue	IM	AD	AD	MR
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Project

DUMAT AL JANDAL WIND
ENERGY PARK

Drawing Title

HARRIER SPECIES
FLIGHT LINES

Drawing Status

Scale @ A3	1:35,630	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-05	

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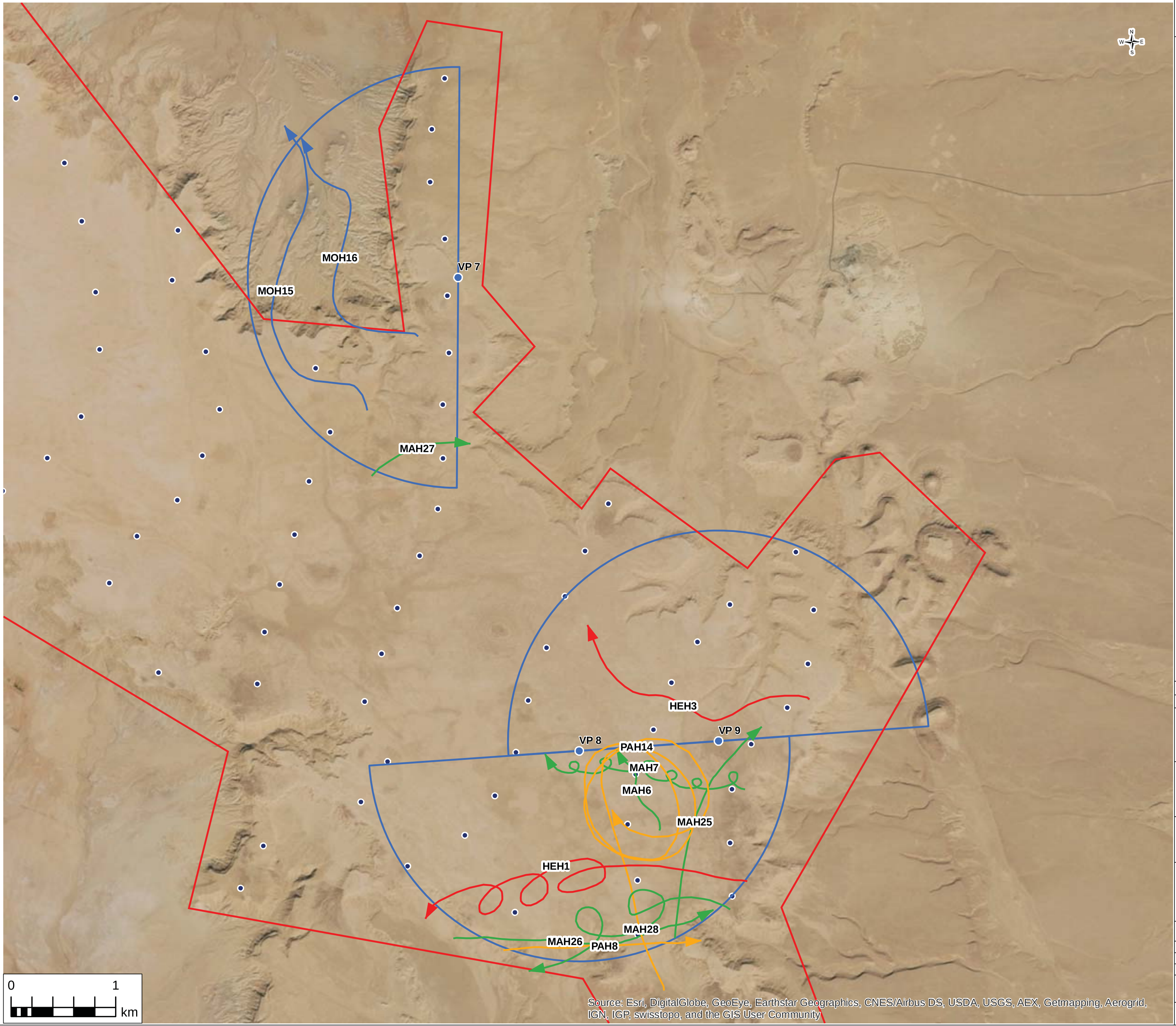

SA217900-DMT-G-PLN-TB18-06

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Pallid Harrier
- Montagu's Harrier
- Marsh Harrier
- Hen Harrier

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Project

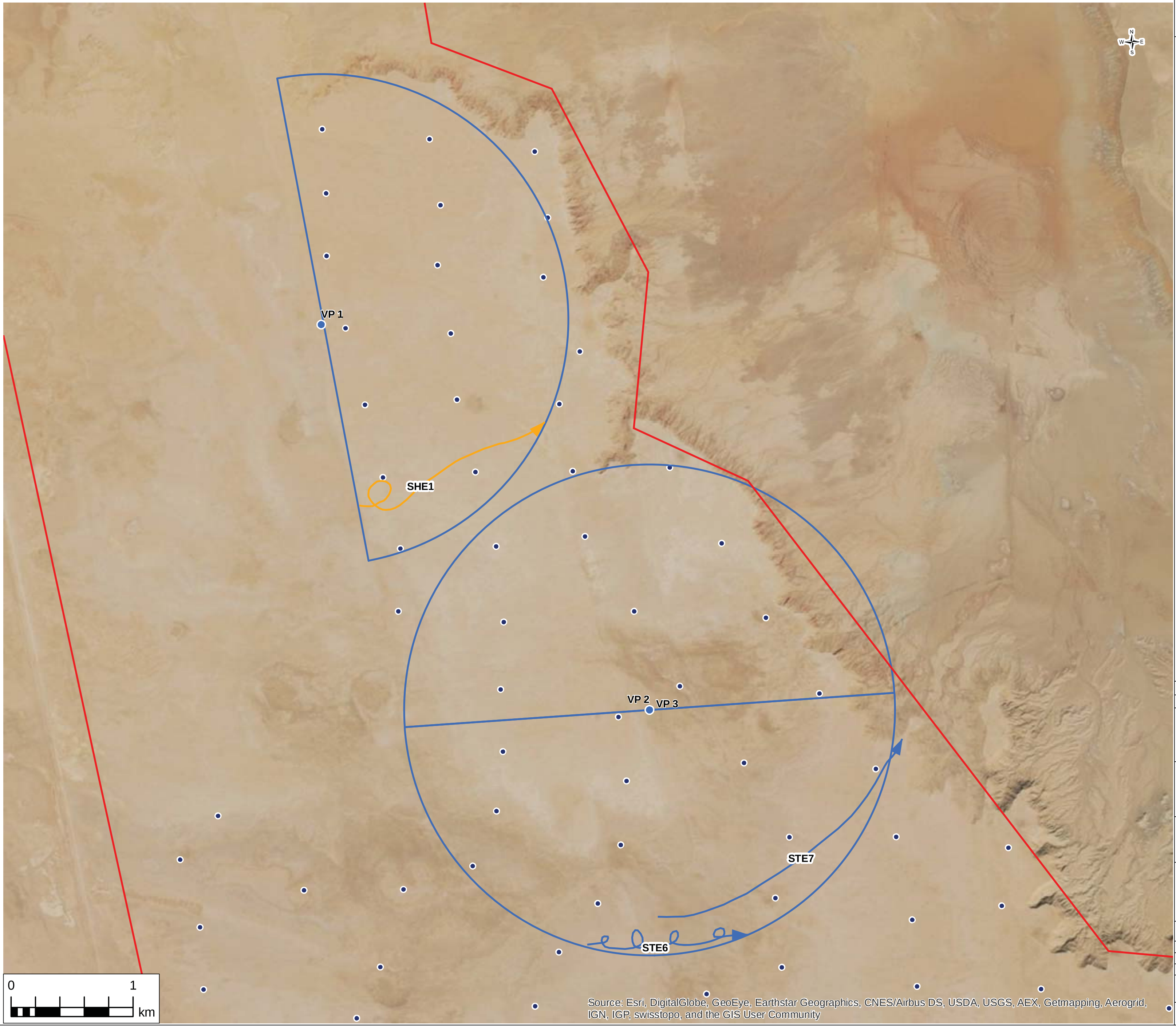
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

HARRIER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-06	



SA217900-DMT-G-PLN-TB18-07

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Short-toed Snake Eagle
- Steppe Eagle

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Client

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Project

DUMAT AL JANDAL WIND ENERGY PARK

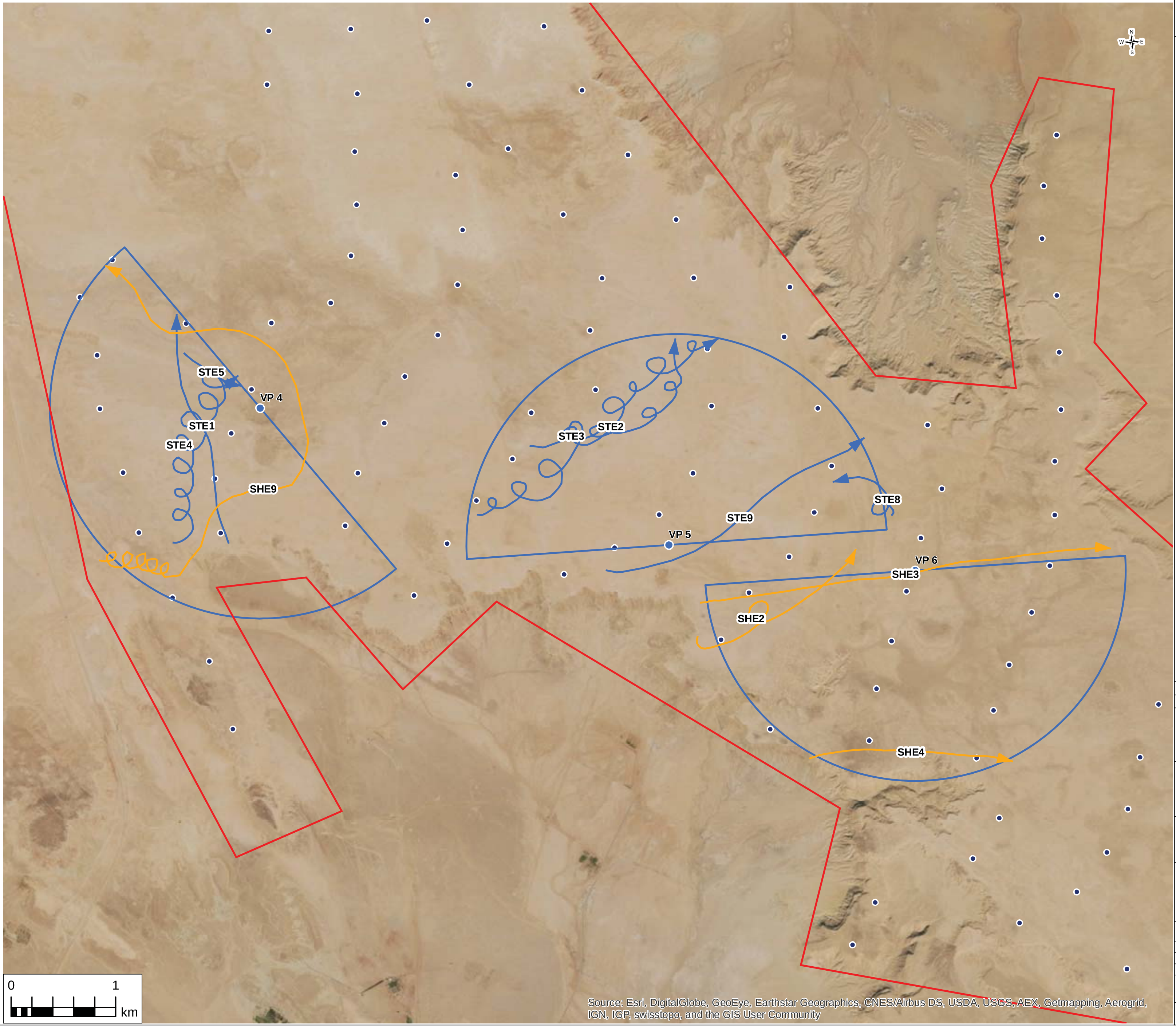
Drawing Title

EAGLE SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-07	

This drawing is not to be used in whole in or part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.



SA217900-DMT-G-PLN-TB18-08

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Short-toed Snake Eagle
- Steppe Eagle

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Client

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Project

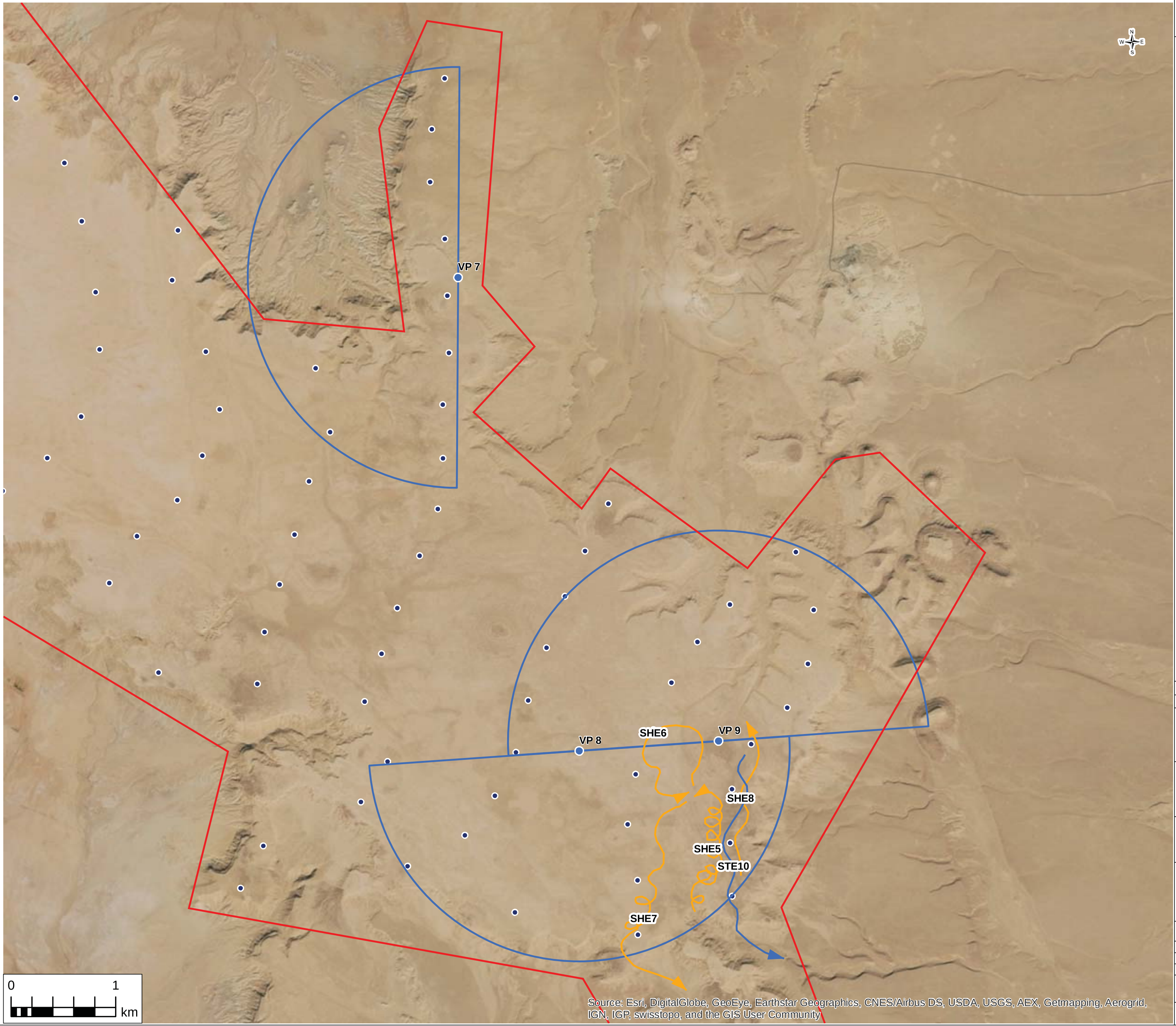
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

EAGLE SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-08	



SA217900-DMT-G-PLN-TB18-09

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Short-toed Snake Eagle
- Steppe Eagle

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Client

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Project

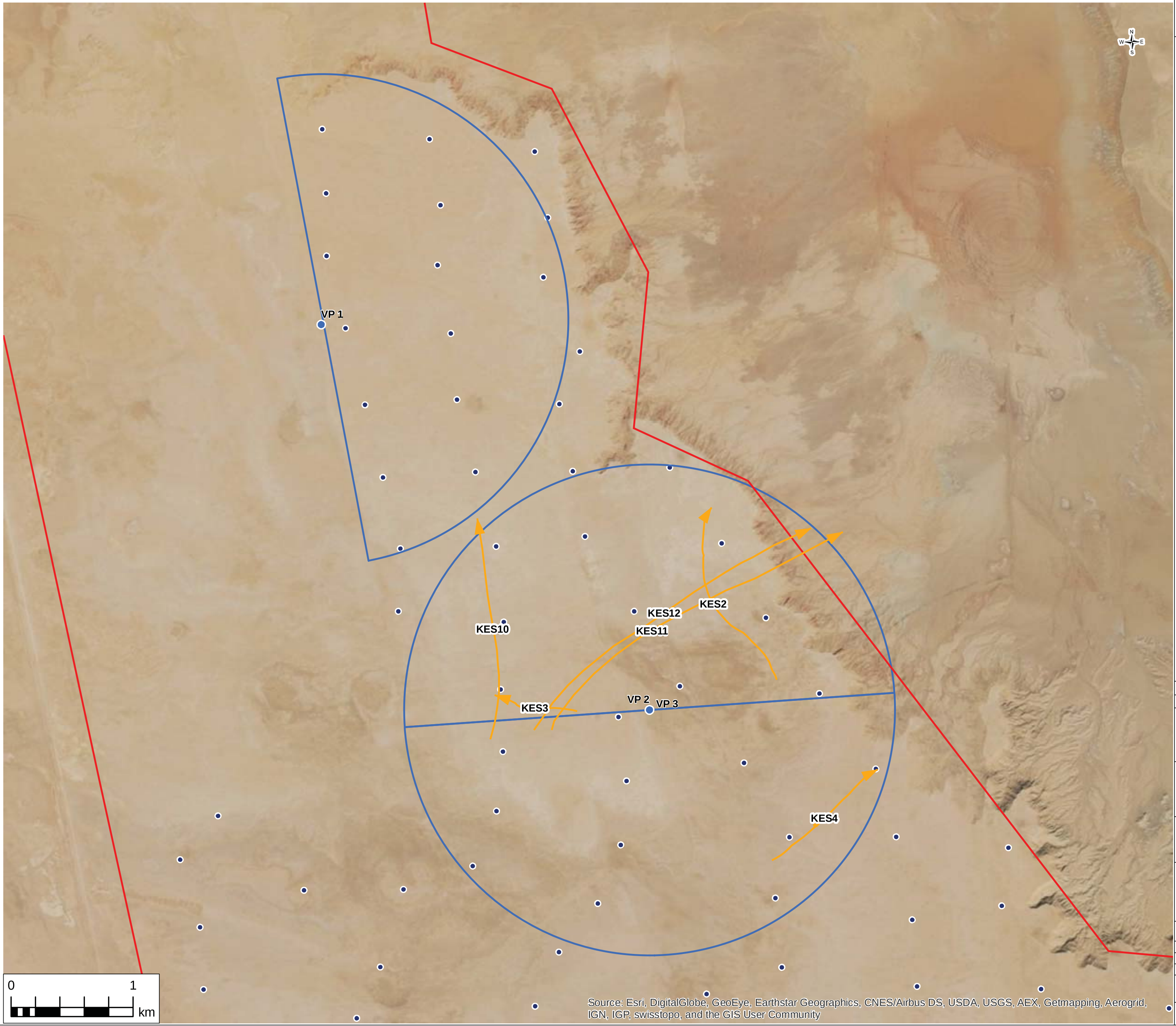
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

EAGLE SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-09	



SA217900-DMT-G-PLN-TB18-10

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Kestrel

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Client

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Project

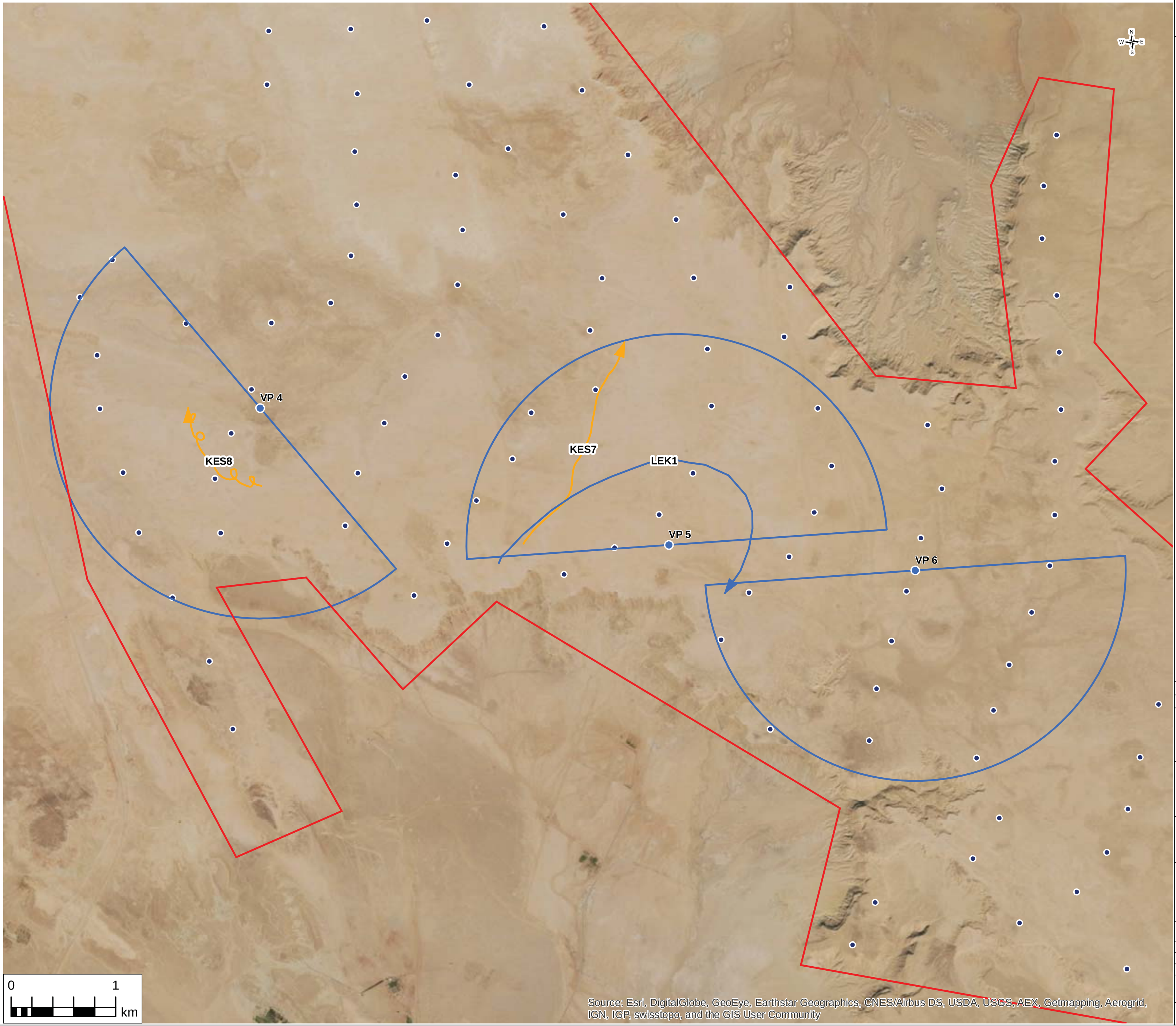
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

FALCON SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-10	



SA217900-DMT-G-PLN-TB18-11

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Kestrel
- Lesser Kestrel

0	JUN 17	Initial Issue	IM	AD	AD	MR
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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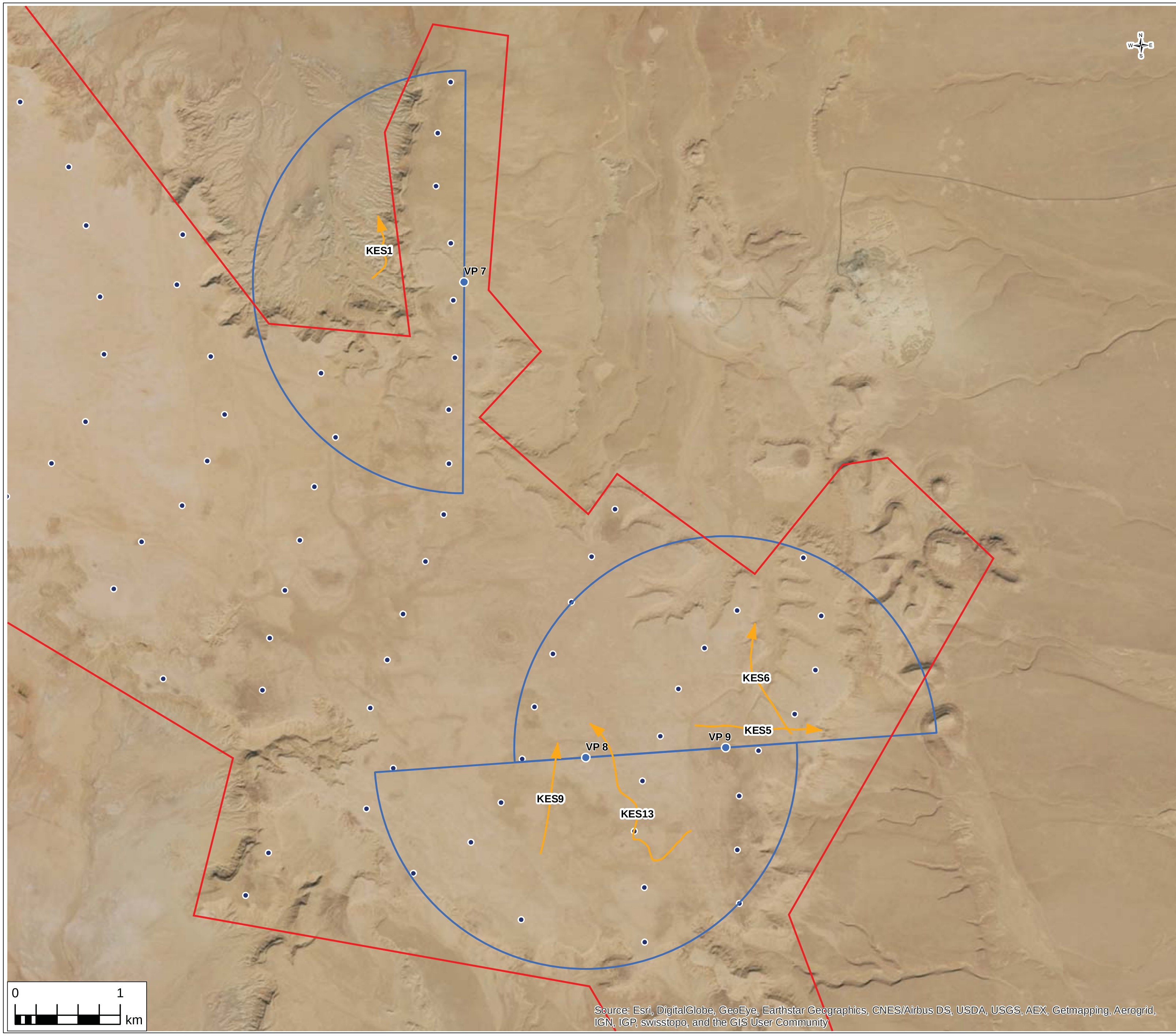
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

FALCON SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-11	



SA217900-DMT-G-PLN-TB18-12

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Kestrel

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Client

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

FALCON SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-12	

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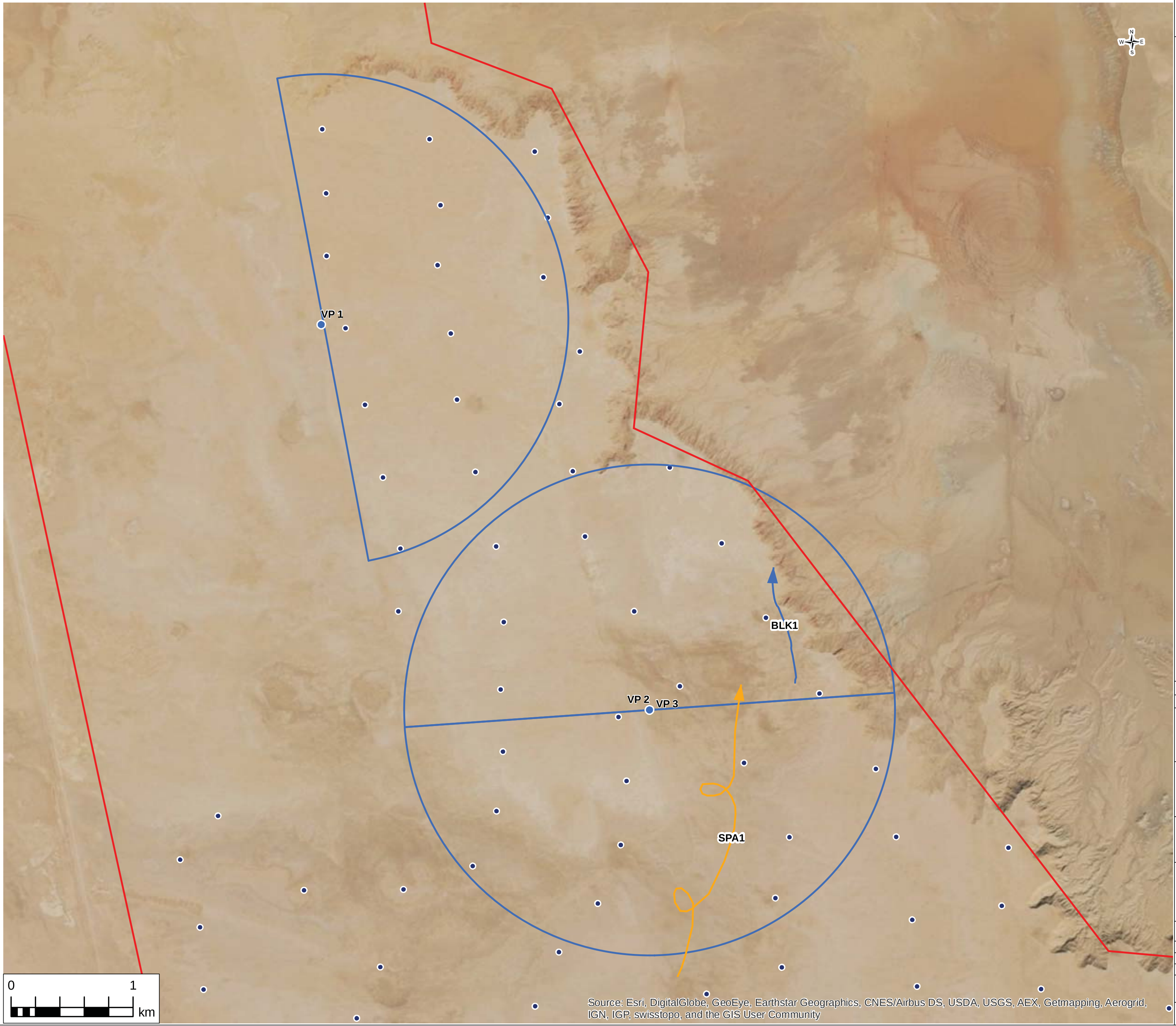

SA217900-DMT-G-PLN-TB18-13

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052

Bird Flight

- Sparrowhawk
- Black Kite

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

OTHER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:30,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-13	

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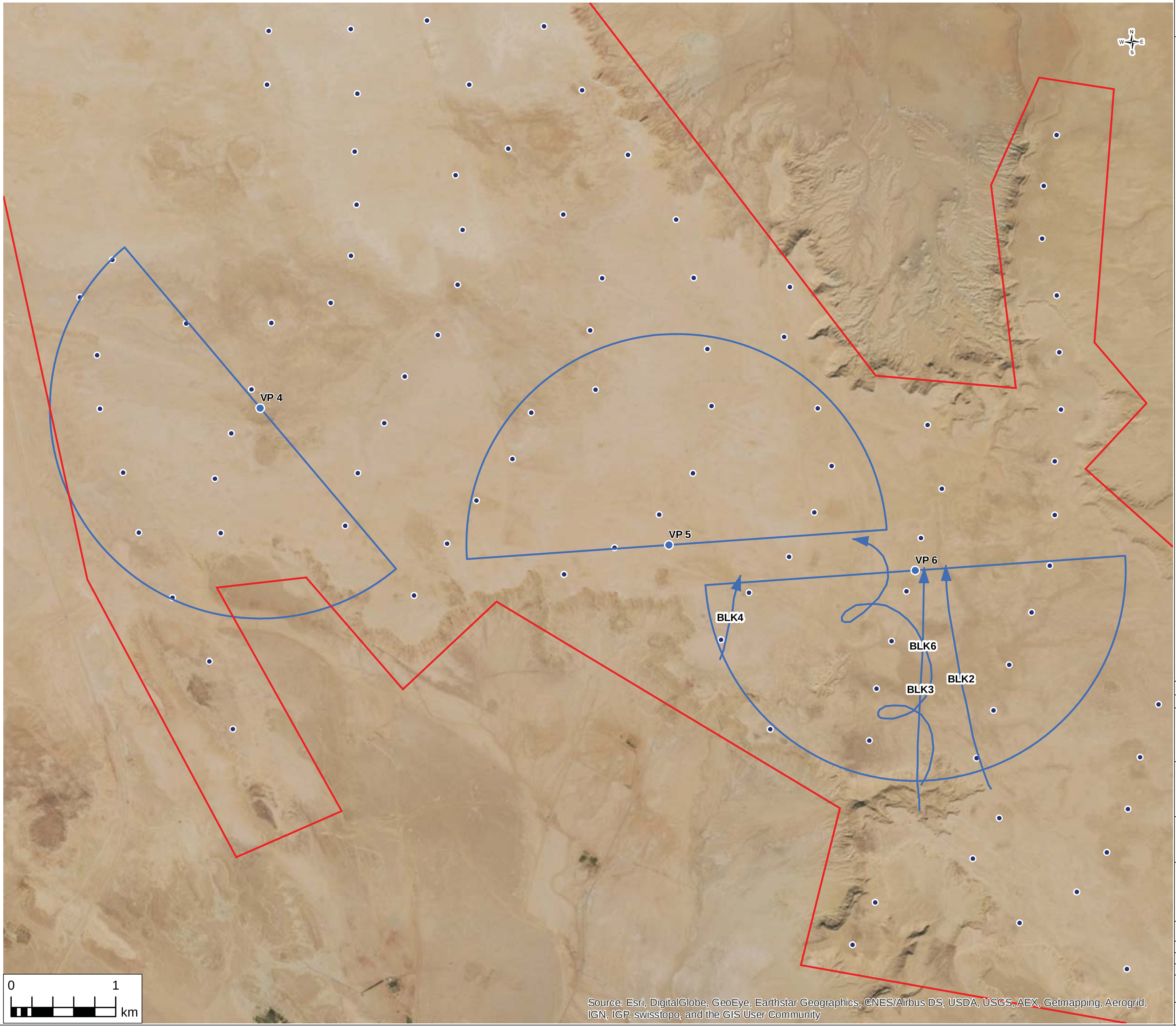

SA217900-DMT-G-PLN-TB18-14

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076

Bird Flight

- Black Kite

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

JACOBS ZATE

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saudi aramco

Project

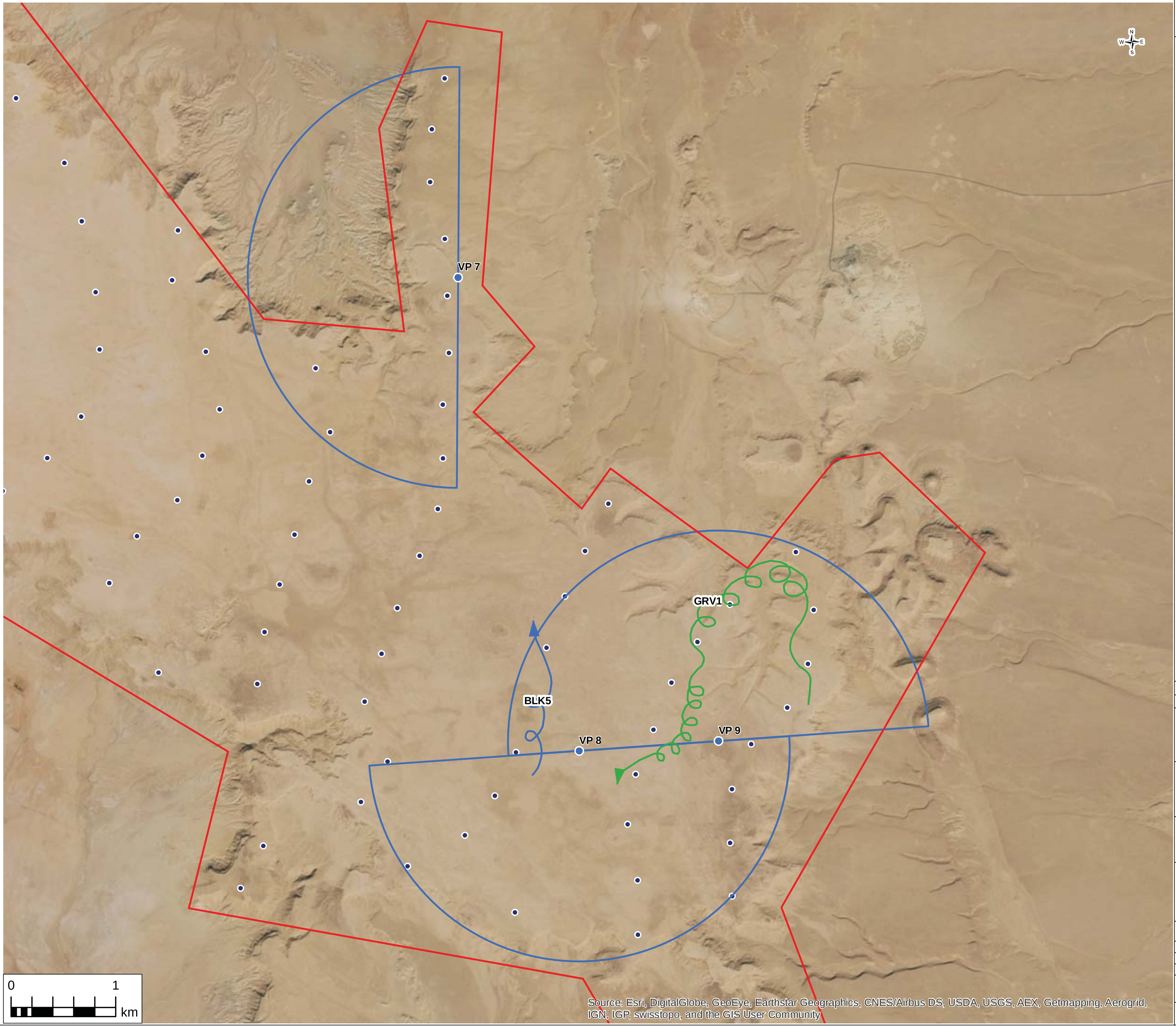
DUMAT AL JANDAL WIND
ENERGY PARK

Drawing Title

OTHER SPECIES
FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-14	



SA217900-DMT-G-PLN-TB18-15

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Bird Flight

- Black Kite
- Griffon Vulture

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

JACOBS ZATE

Client

أرامكو السعودية saudi aramco

Project

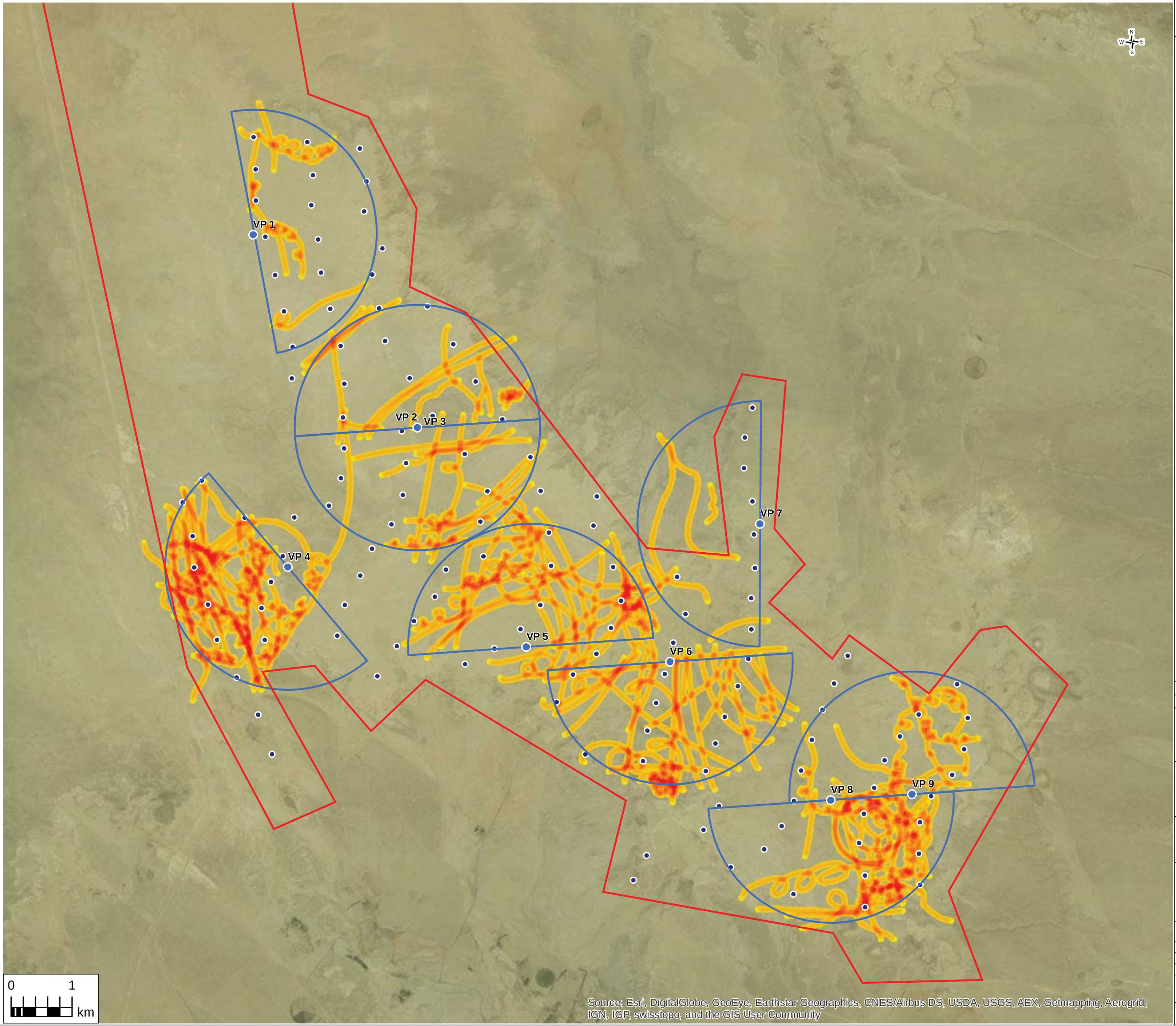
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

OTHER SPECIES FLIGHT LINES

Drawing Status

Scale @ A3	1:35,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-15	



SA217900-DMT-G-PLN-TB18-16

Legend

- Study Area
- Indicative Turbine Layout
- View Point Arcs

Viewpoints

- VP 1, 576812.37045, 3325248.36172
- VP 2, 579261.93241, 3321929.44052
- VP 3, 579261.93241, 3321929.44052
- VP 4, 576997.98329, 3319810.02842
- VP 5, 580781.6906, 3318240.95766
- VP 6, 583101.04119, 3317834.98076
- VP 7, 584725.68236, 3319973.7994
- VP 8, 585559.57385, 3315403.0358
- VP 9, 586886.032, 3315404.94842

Relative Density of Flight Lines

Higher

Lower

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Project

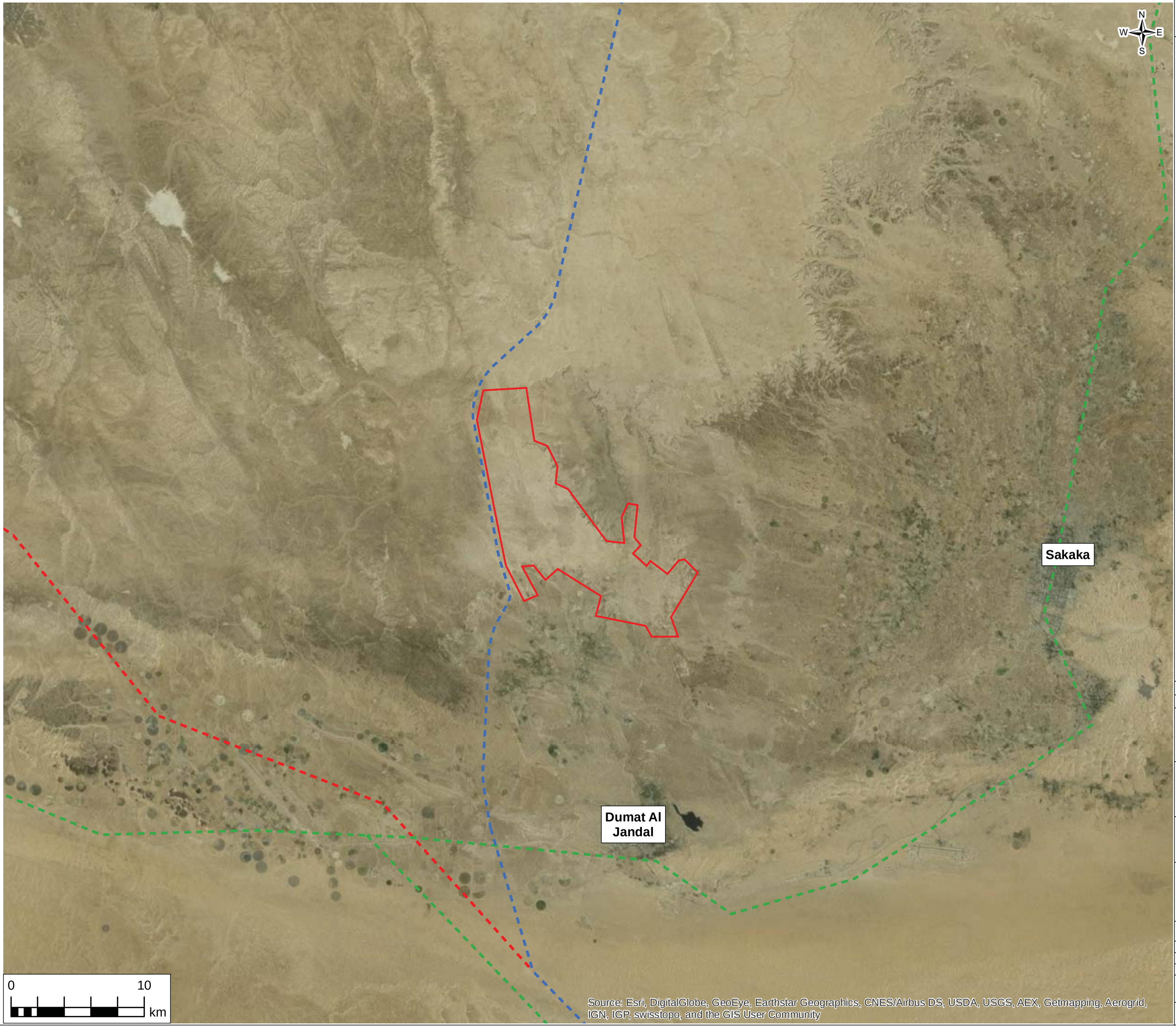
DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

ALL SPECIES FLIGHT LINES SPRING SURVEYS

Drawing Status

Scale @ A3	1:60,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TB18-16	



SA217900-DMT-G-PLN-TR03

Legend

- Site Boundary
- Rail (In Operation)
- Rail (Proposed)
- Major Roads

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JAN 17	Initial Issue	IM	AD	AD	MR

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Project

DUMAT AL JANDAL WIND ENERGY PARK

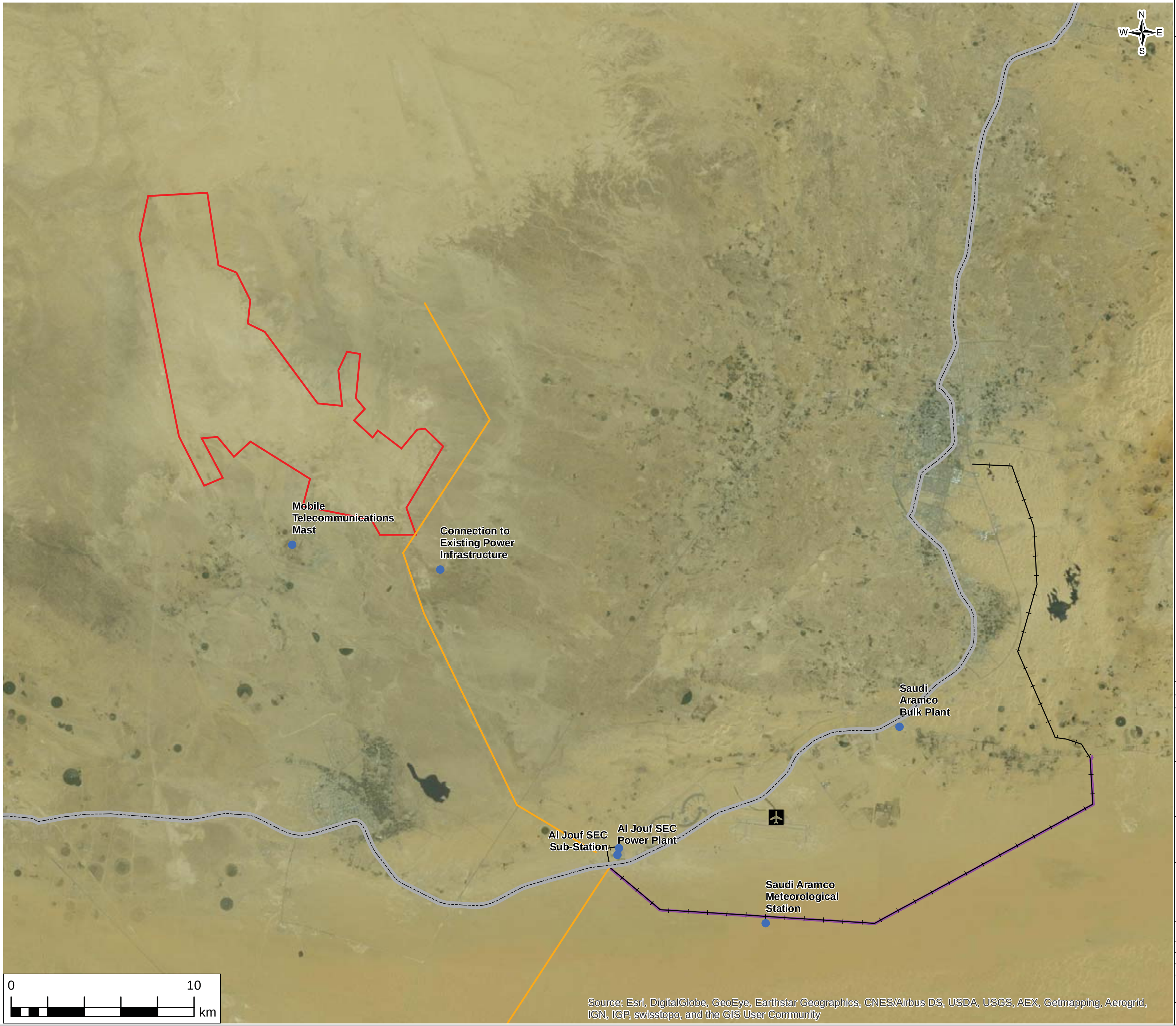
Drawing Title

TRANSPORTATION INFRASTRUCTURE

Drawing Status

Scale @ A3	1:275,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-TR03	

SA217900-DMT-G-PLN-UT03



Legend

- Site Boundary
- Utilities
- Al Jouf International Airport
- Road 80
- Existing 132kV Line
- Existing 380kV Line
- SEC Utility Corridor (Service Road)

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	JUN 17	Initial Issue	IM	AD	AD	MR

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Project

DUMAT AL JANDAL WIND ENERGY PARK

Drawing Title

UTILITIES AND INFRASTRUCTURE

Drawing Status

Scale @ A3	1:200,000	DO NOT SCALE
Jacobs No.	SA217900	
Client No.		
Drawing No.	SA217900-DMT-G-PLN-UT03	