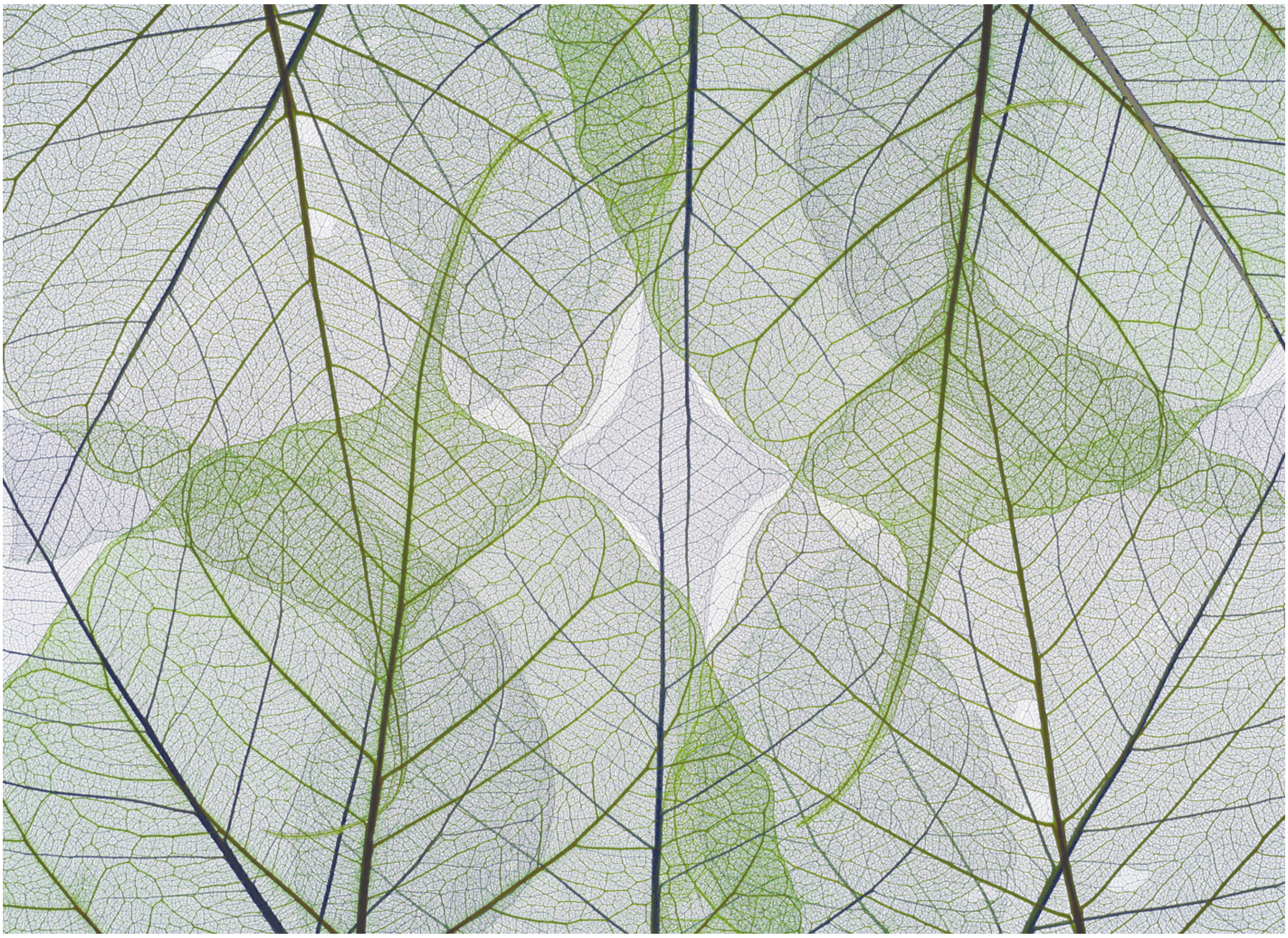

Pearl Petroleum Company Limited

Khor Mor 250A MMscfd Expansion for KM500 Gas Treatment Plant, Kurdistan Region of Iraq

Environmental and Social Impact Assessment

182279-17 (05)

APRIL 2020

RSK

RSK GENERAL NOTES

Project No.: 182279-17 (05)

Title: Environmental and Social Impact Assessment for first 250 MMscfd for KM500 Gas Treatment Plant - Khor Mor, Kurdistan Region of Iraq

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GLOSSARY

Term	Definition
°C	degrees Celsius
μg/m^3	micrograms per cubic metre
μS/cm	micro Siemen per centimetre
ADMS	atmospheric air dispersion modelling study
AIDS	Acquired Immunodeficiency Syndrome
ALARP	as low as reasonably practicable
Am^3	Am^3 is gas volume in cubic metres at the actual operating conditions of the process
AOI	area of influence
AOO	area of occurrence
BAT	best available technology
BID	Background Information Document
BOD	biochemical oxygen demand
bpd	barrels per day
BPIP	Building Profile Input Program
BS	British Standard
cfu	colony forming units
CHA	critical habitat assessment
CO	carbon monoxide
CO_2	carbon dioxide
CoC	Code of Conduct
CPDG	Crescent Petroleum and Dana Gas
dB(A)	decibel (A weighted)
DEA	di-ethylamine
DFC	U.S. International Development Finance Corporation
DG	diesel generator
DO	dissolved oxygen
EHS	environment, health and safety
EIA	environmental impact assessment
EN	endangered
EOO	extent of occurrence
EPA	United States Environmental Protection Agency
EPC	engineering, procurement and construction
EPF	early production facility
EPH	extractable petroleum hydrocarbons

Term	Definition
ERP	emergency response plan
ES	ecosystem services
ESD	emergency shut down
ESIA	environmental and social impact assessment
ESMP	environmental and social management plan
ESMS	environmental and social management system
FDP	field development plan
FEED	front-end engineering design
FGD	focus group discussion
GBV	gender-based violence
GDP	gross domestic product
GHG	greenhouse gases
GII	Gender Inequality Index
GIIP	good international industry practice
GoI	Government of Iraq
H_2S	hydrogen sulphide
ha	hectare
HAZID	Hazard Identification study
HAZOP	Hazard and Operability study
HDI	Human Development Index
HDPE	high density polyethylene
HGV	heavy goods vehicle
HH	household
HIV	Human Immunodeficiency Virus
HP	high pressure
HSSE&SP	Health, Safety, Security, Environment and Social Performance
IDP	internally displaced person
IEMA	Institute of Environmental Management Association
IFC	International Finance Corporation
IGA	income generating activities
ILO	International Labour Organisation
IPs	indigenous peoples
IOM	International Organisation for Migration
IQD	Iraqi Dinar
ISIS	Islamic State of Iraq and Syria
IUCN	International Union for the Conservation of Nature

Term	Definition
KBA	key biodiversity area
KII	key informant interviews
KM	Khor Mor
km	kilometre
KM250A	Khor Mor 250A expansion
KM500	Khor Mor 500 expansion
KO	Knock-out
KPI	key performance indicator
KRG	Kurdistan Regional Government
KRI	Kurdistan Region of Iraq
KRSO	Kurdistan Regional Statistics Office
L	litre
L_{A10}	noise level exceeded for 10% of the measurement period (A-weighted)
L_{A90}	noise level exceeded for 90% of the measurement period (A-weighted)
L_{Aeq}	equivalent continuous sound pressure level (A-weighted)
L_{Amax}	maximum value sound pressure level during a measurement period (A-weighted)
LC	least concern
LLP	low-low pressure
LP	low pressure
LPG	liquified petroleum gas
LRP	Livelihood Restoration Plan
LCEP	Local Community Employment Plan
LT	low temperature
m	metre
m/s	metres per second
mbtoc	metres below top of casing
MDEA	methyl-di-ethylamine
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mg/m^3	milligrams per cubic metre
MMIF	Mesoscale Model Interface Program
MMscfd	million metric standard cubic feet per day
MNR	Ministry of Natural Resources
MoAWR	Ministry of Agriculture and Water Resources
MP	Management Plan
MS	Management System

Term	Definition
MSW	municipal solid waste
MW	megawatt
NA	not analysed
NAAQS	national ambient air quality standards
NACE	National Association of Corrosion Engineers
NCD	non-communicable diseases
ND	not detected
NGL	natural gas liquids
NGO	non-governmental organisation
NM	not measured
NOx	nitrogen oxides
NS	not specified
NTS	Non-technical Summary
NTU	Nephelometric turbidity unit
O_3	ozone
OHS	occupational health and safety
OPF	Oil Police Force
PAC	Project-affected community
PAH	polycyclic aromatic hydrocarbons
PAP	Project-affected person
PDA	Production Development Agreement
PHC	primary health care
PM_{10}	particulate matter (PM_{10} particles smaller than 10 microns)
$PM_{2.5}$	particulate matter ($PM_{2.5}$ particles smaller than 2.5 microns)
PMT	Pearl Petroleum management team
ppb	parts per billion
ppm	parts per million
PS	Performance Standard
QRA	qualitative risk assessment
RoW	right of way
RP	Retrenchment Plan
RSK	RSK Environment LLC
SDM	Sub-District Manager
SIMOPS	simultaneous operations
SIP	Social Investment Programmes
SLO	Social Liaison Officer

Term	Definition
SO_2	sulphur dioxide
SO_x	sulphur oxides
SPD	Social Performance Department
SPL	sound pressure level
SRU	sulphur recovery unit
STP	sanitary treatment plant
SWL	static water level below datum
tCO_2	total carbon dioxide
TPH	total petroleum hydrocarbons
VCP	vehicle check point
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbons
VU	vulnerable
WHO	World Health Organisation
WMP	Waste Management Procedure
WRF	Weather Research Forecast

NON-TECHNICAL SUMMARY

This Non-Technical Summary (NTS) presents the findings of the detailed Environmental and Social Impact Assessment (ESIA) undertaken by RSK Environment (RSK) for the expansion of an existing gas treatment and liquified petroleum gas (LPG) extraction facility operated by Pearl Petroleum Company Limited (Pearl Petroleum) at Khor Mor (KM) in the Kurdistan Region of Iraq (KRI). The expansion will process 250 million standard cubic feet per day (MMscfd) of natural gas and liquid petroleum product and is known as the 'KM250A Project'.

Construction is anticipated to start at the end of the second quarter (Q2) of 2020, with first production of sales gas, LPG and condensate expected during Q1 2022.

Justification for the Project

The KM250A Project will increase the production of natural gas and liquid petroleum products at the site, contributing further to the KRI's energy supply through more efficient, cleaner electricity generation, and will provide local employment and business opportunities for provision of goods and services. As the only gas supplier to regional power stations, Pearl Petroleum provides a clean and highly cost-effective alternative solution to diesel-fuelled power generation.

ESIA purpose and process

The ESIA has been conducted in accordance with legal and regulatory requirements of Iraq and the Kurdistan Regional Government (KRG) Ministry of Natural Resources (MNR), especially KRI Law Number (8) of 2008 'Environmental Protection and Improvement in Iraqi Kurdistan Region' as well as World Bank Group/International Finance Corporation (IFC) Performance Standards (PS) and Environmental Health and Safety (EHS) Guidelines. All aspects of petroleum operations (that is exploration, marketing, transportation, storage) require an environmental impact assessment in the KRI.

The purpose of the ESIA is to identify how people and the environment could be affected by the KM250A Project (positively or negatively) and to put forward control measures (mitigations) to avoid, minimise or offset any negative effects. Environmental and social baseline data on the physical environment (air quality, noise, soil and water resources), the biological environment (habitat, flora and fauna, biodiversity) and the social environment (such as demographics, economy and livelihoods and health and education) was collected from a variety of data sources including previous studies undertaken in the Project area and desktop data. This was supplemented by additional environmental and social baseline surveys, undertaken within a pre-defined area of influence (AOI), to identify baseline conditions.

The ESIA process is presented in Figure 1. The KM250A Project activities for each phase (construction, pre-commissioning/commissioning, operations and decommissioning) were identified and the potential significance of impacts were assessed based on baseline environmental and social conditions, receptor (such as people, water resources, biological environment), sensitivity and impact magnitude.

Predicted impacts were assessed against the KM250A Project Standards, which were selected from applicable KRI and Government of Iraq regulations and relevant international standards, including IFC PS and World Health Organisation (WHO) standards.

Mitigation measures were recommended to avoid or reduce impacts with moderate, high or major significance. Impacts were re-assessed with the mitigation(s) applied to determine any residual impact. Actions to maximise positive benefits were also identified.

The mitigation measures are due to be implemented for the KM250A Project via the KM250A Project Health, Safety, Security, Environment and Social Performance Management Plan (KM250A HSSE&SP MP). This will include the requirement for monitoring key parameters.

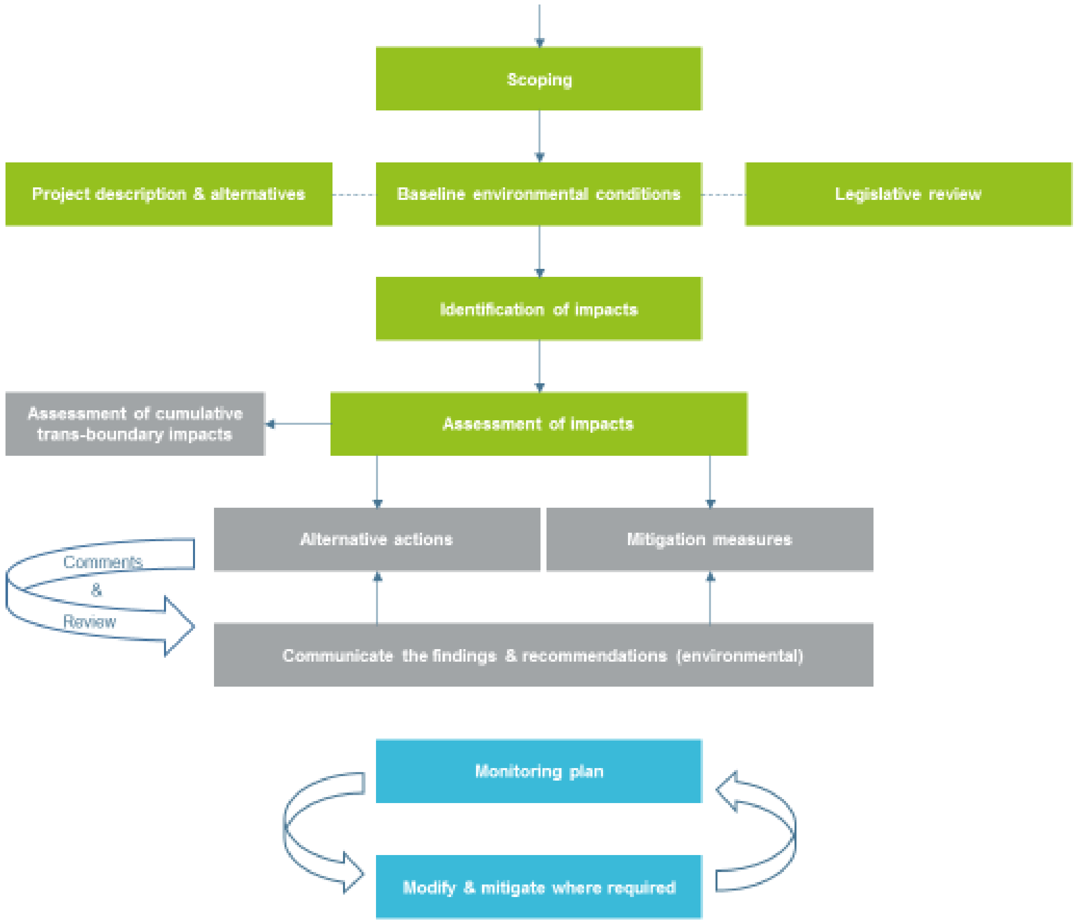


Figure 1 ESIA process

KM250A Project context

Site location

The KM250A Project site is located in Sulaymaniyah Governorate in the KRI, approximately 195 km south-east of Mosul (Figure 2). The KM250A Project site comprises 225 hectares (ha) within the existing 600 ha site and new flowlines that will be constructed to connect wells to the site. The various parts of the KM site where KM250A Project infrastructure will be installed are shown in Figure 3. The main KM250A Project gas plant infrastructure will be placed in the KM Expansion Area.

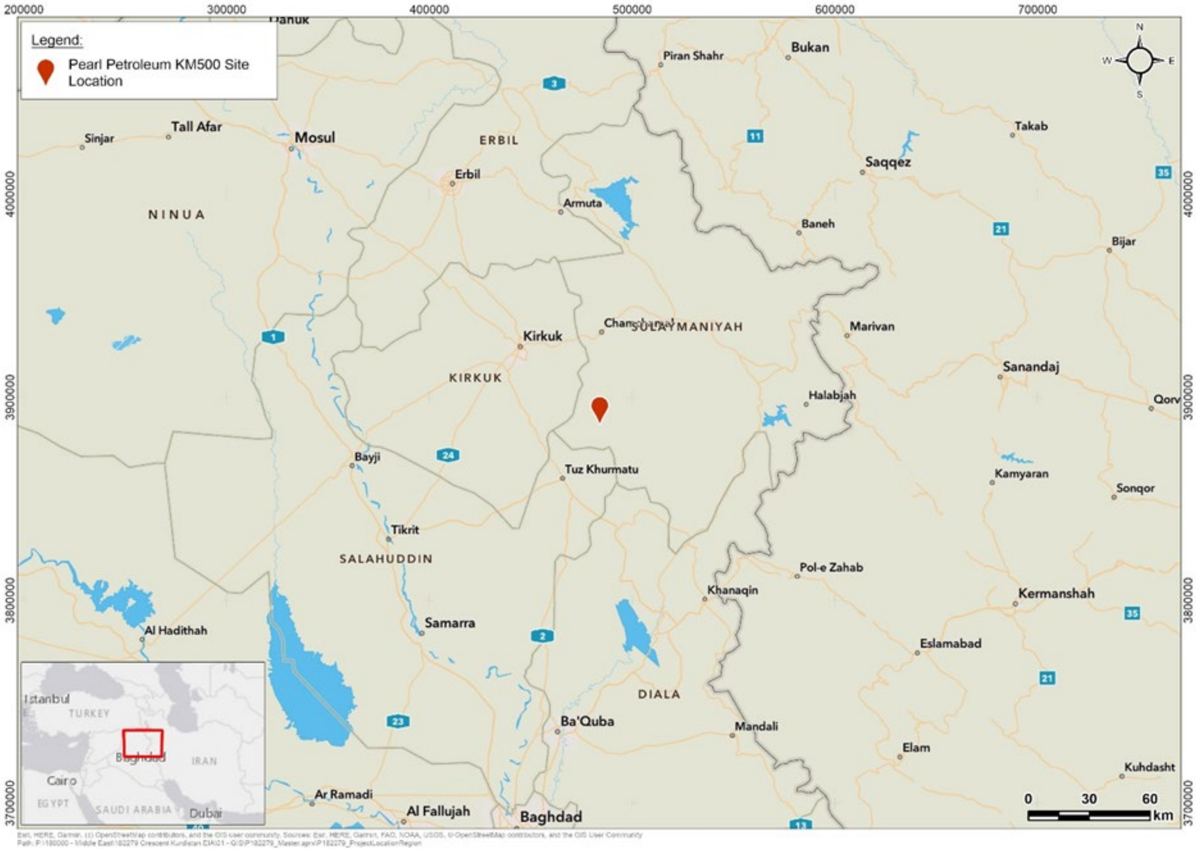


Figure 2 KM250A Project site location

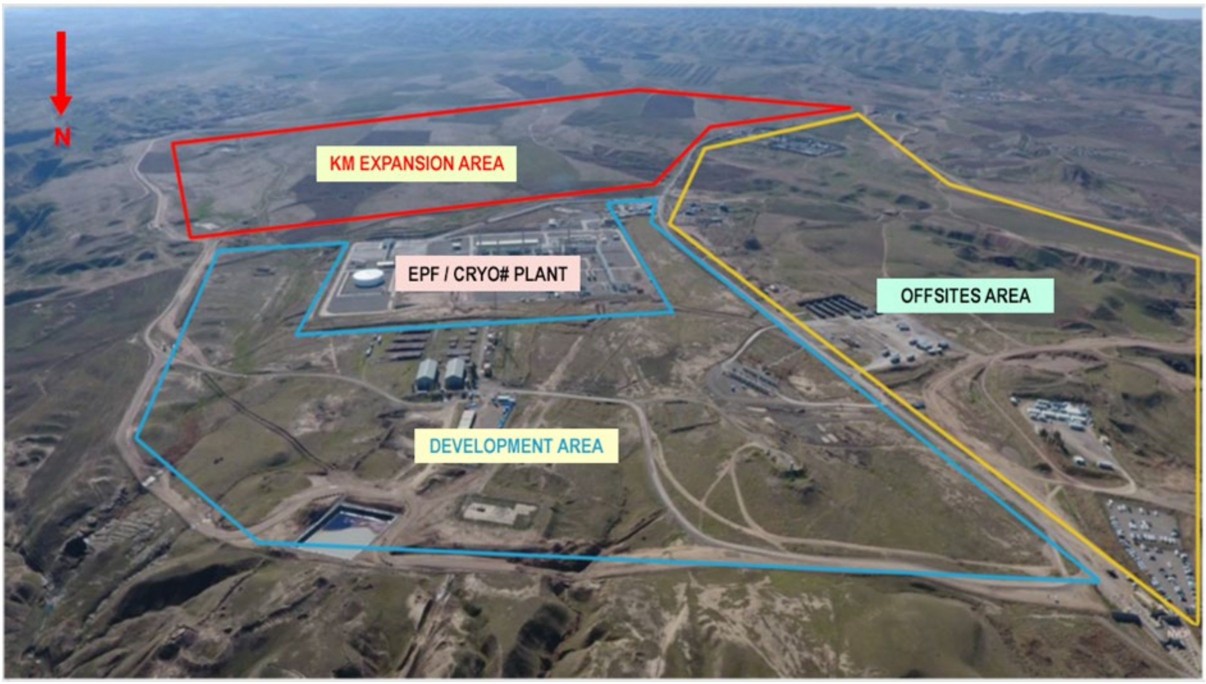


Figure 3 KM site

Local communities

Several communities are located within 10 km of the KM250A Project site (Figure 4), most of which are relatively small, with less than 100 residents. The average distance of the three nearest communities - Awaye Jalal, Khor Mor Bichuk and Khor Mor Gawra - from the nearest boundary of the KM Expansion Area is 2 km.

Land ownership and usage

The KM250A Project will be mostly constructed on land which is already occupied by Pearl Petroleum. New flowlines will, however, be installed outside the existing site on land currently used for livestock rearing and crop farming. To allow the flowlines to be laid during construction and to ensure that the flowlines are not damaged during operations, permissions to acquire or access the land within the flowline corridors will need to be obtained, and restrictions to land use will be put in place (e.g. through restricting digging activities or the construction of buildings).

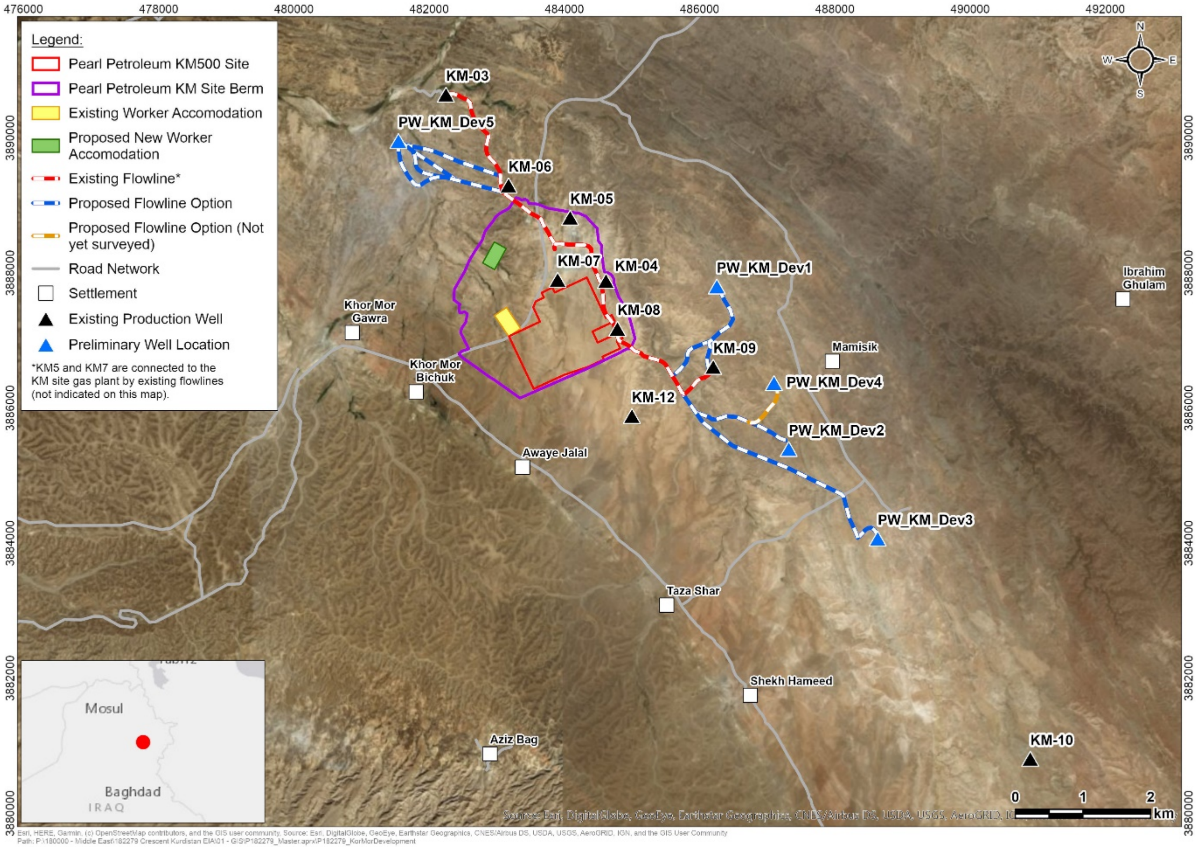


Figure 4 KM25A Project site and surrounding area

Water and power supply

Groundwater wells are the main source of water for the local communities. Some of these are privately owned by Pearl Petroleum whereas others have been drilled by local residents and are community-owned. Some community members also obtain water from ponds and seasonal springs. Challenges with regard to the quality, quantity and reliability of water are widespread and have reportedly increased in recent years.

Electricity provided by Pearl Petroleum (as part of the Pearl Petroleum Social Investment Plan) and/or the Government are the main sources of energy for lighting in local communities in the Project area. Electricity generated at the KM site is provided to some communities directly by Pearl

Petroleum via power lines. Diesel-powered generators and traditional energy sources (e.g. candles, oil lamps) provide alternative means of energy supply for households in communities without access to the electricity grid or to provision of electricity by Pearl Petroleum. Pearl Petroleum provides diesel for generators in some communities.

Employment

The existing operations are an important source of formal employment in the local communities (either directly or indirectly through contractors and sub-contractors) and business opportunities for local and regional companies. The majority of households in the local communities are, however, engaged in agricultural activities such as crop farming and/or livestock rearing. The resulting produce is both consumed within households and sold for cash income.

Waste management

In most of the local communities, solid waste is either burned in private waste pits or disposed of at waste collection points. Waste deposited at collection points is collected by a private company, contracted by the local government, and burned or deposited in landfills. Almost all food waste is fed to livestock. There are landfill sites in the general Project area approved by the KRG that receive unsorted non-hazardous municipal waste (food waste, plastic, cans, bottles, aluminium, scrap metal). Current practice in Iraq is to send these types of waste to landfill sites until recycling options become available. A facility for managing hazardous wastes to international standards does not currently exist in Kurdistan.

KM250A Project description

The KM250A Project comprises the construction of a new gas processing facility within the existing KM site boundary and up to five new flowlines that will transport raw gas from new production wells (considered as associated facilities and subject to an additional detailed ESIA) to the KM250A Project site. The KM250A Project will also include the following components:

- a central control building and laboratory
- new site utilities and power generation
- workshops, yards, offices and an accommodation camp
- flares for routine and non-routine flaring events
- lined evaporation pond.

The ESIA includes details of alternatives that Pearl Petroleum considered for the KM250A Project for gas dehydration, desulphurisation, acid gas disposal, condensate storage tank venting, compression, as well as the ‘do nothing’ option.

During all phases of the KM250A Project, labour will be employed from the local area to the maximum extent possible and training and development opportunities will be provided to all staff. Contracting and procurement procedures will be fair and equitable, and preference will be given to procurement of goods and services originating from Kurdistan, when such goods and services are internationally competitive with respect to quality, availability, price and performance.

KM250A Project activities

Construction phase

Early works activities will include site preparation (civil works), including levelling, clearance of vegetation, excavation for foundations) and the construction of internal roads, culverts and ditches. The site will be cleared of vegetation as necessary. The areas designated for the gas plant and associated infrastructure will be levelled. The engineering, procurement and construction (EPC) Contractor will address any issues related to geo-hazards (for example landslides) that are identified at the site. Where the foundations of the process train are to be constructed, natural soil will be removed before constructing shallow or spread foundations for critical and heavy equipment. Material backfilled over the foundations will be compacted. Cut and fill earthworks will be undertaken. No net soil will be required for levelling the gas plant site. Gravel and aggregate will be sourced from a local quarry.

The roadways on the site will be excavated to the road structural thickness below ground level. The construction contractor will excavate conduits for drains, perimeter drainage ditches and wastewater evaporation ponds.

Water will be sprayed to suppress dust while earthworks are undertaken.

Construction of the gas processing facility and associated flares and infrastructure will be pre-assembled as far as possible, given transport limitations, to minimise site construction work. Flowlines will be below ground and will require excavation, pipelaying and backfilling. The section of the existing condensate export line located within the fenceline will be re-routed as part of the KM250A Project.

The process equipment, pipe racks and piping will be pre-assembled as far as possible, with a view to minimising site construction work based on compliance with the transport envelope and adherence to the design, operability and maintainability of equipment. Modules of process equipment will have been hydrostatically tested (hydrotested) before leaving the supplier. New welds will be hydrotested at the site.

The buried flowline installation stages are as follows:

- right of way (RoW) preparation, stripping and grading
- pipe stringing
- welding
- excavating the trench
- lowering flowline segments into the trench
- backfilling the trench.

Flat-bed trailers will transport the pipe sections to the laydown areas where they will be stockpiled. When the RoW has been marked out, trucks will set down sections of pipe along the route, laying the ends on sandbags or pipe holders to protect the pipeline coating. A mechanical excavator will dig a trench of suitable width and depth for the diameter of the pipeline in question along the marked pipeline route. Soil from excavating the trench will be placed into heaps running beside the trench. The trench will be deep enough to allow the pipeline to be buried with 1.2 m of fill over the top of the pipe.

Where a new flowline is to be installed alongside an existing hydrocarbon pipeline, appropriate separation distances will be observed to prevent accidental damage to the existing pipeline.

Much of the construction material (including equipment modules) will be delivered to Mercin Port in Turkey and transported by road to the KM250A Project site. Construction traffic will use existing roads.

Chemicals and hazardous materials will be used during construction, including diesel fuel, lubricating oil and hydraulic oil. Hazardous wastes (such as batteries, tyres, waste hazardous substance packaging waste, oil filters, paint) and non-hazardous waste (such as domestic and packaging) will be generated.

During the construction phase, Pearl Petroleum and their contractors will utilise vehicles , machinery and site equipment powered by internal combustion engines. This can result in the emission of exhaust gases containing air pollutants such as nitrogen oxides (NOx), particulate matter particles smaller than 10 microns (PM10), volatile organic compounds (VOCs) and carbon monoxide (CO). The quantities of exhaust gas emitted will depend on factors such as engine type, service history, pattern of usage and fuel composition.

Site preparation will involve the use of equipment that generate noise, especially:

- construction plant including excavators, bulldozers, asphalt pavers and rollers
- graders, concrete mixer trucks and dump trucks
- large power generators

Delivery of process modules by road will involve the use of haulage trucks that generate relatively noise. Installation and erection of process modules will involve the use of cranes and welding set generators also generate noise.

Pipeline construction will involve the use of:

- excavators, side booms and welding sets
- dump trucks
- a rock breaker

Noise sources related to pipeline construction will be mobile within the limits of the Project site and the flowline RoWs.

An estimated 300 L of sanitary wastewater per person per day (6,000 m3/month) will be generated during the Project construction period. This will be stored in sewage holding tanks at the construction camp and at the various construction sites and treated at a temporary sanitary treatment plant at the construction camp. Sewage sludge from the septic tanks will be removed by vacuum truck. Waste lubricating and hydraulic oils generated during construction or by maintenance will be contained in a slop tank and sent to an authorised waste oil recycling facility offsite.

Non-hazardous solid wastes including packaging, food waste, plastic and glass containers, wastepaper, card and wood will be generated during the construction period. Segregation of these wastes will be implemented following current KM site recycling practices. Surplus excavated soil will be spread over the Project site. Hazardous waste such as batteries, tyres, hazardous substance packaging waste, oil filters, paint and used PPE will be handled, stored and disposed in accordance with Pearl Petroleum's Waste Management Procedure (WMP), the EPC Contractor Waste Management Plan and current KM site practice.

Construction activities are not planned to take place at night, but this may be necessary at times.

The construction phase will require 500 to 1000 workers who will travel to the site from the local area or will stay at the construction accommodation camp. An area in the south of the KM Expansion Area has been selected for the construction camp. The construction camp will be self-contained and include contractor accommodation, catering/welfare facilities, workshops, warehouses and equipment/piping/materials laydown areas. Some workers will travel to the site from the Chemchemal and Kirkuk areas. Pearl Petroleum expects the construction contractor's workforce to start at low levels when the site is being cleared and the construction camp being prepared.

Transport of people and equipment will be required during the construction phase of the Project. Logistics will be assessed and specified during the EPC phase of the Project. Access routes will be required for bringing the construction workforce to the site and for importing equipment and raw materials. Local construction workers are expected to use the local roads to commute to site.

Pre-commissioning and commissioning phase

The goal of pre-commissioning is to ensure that all equipment functions safely and performs as expected. Individual process units will be tested before delivery to the site. Once installed, the flowlines will be pressure-tested with inert gas and hydrotested using water so that any leaks can be identified and repaired. The use of water and chemicals will be minimised by re-using hydrotest water where possible. When hydrotesting is complete, the spent hydrotest water will be tested to determine if it can be discharged to land, treated or discharged to the lined evaporation pond.

Following pre-commissioning, the commissioning team will then put the flowlines and KM250A Project gas plant into operation. The process train modules will be tested individually and will flare gas for a short duration until the export product specifications are met.

Operations phase

Once the KM250A Project has been commissioned, the facility will operate 24 hours a day; Pearl Petroleum will have dedicated management and operations teams with autonomy over the KM250A Project process facilities, utilities, power supply and emergency systems. The control centre will also electronically monitor the operation of the flowlines. Plant lighting at night will be required.

Following processing at the KM250A Project site, sales gas will be routed through an existing 24'' sales gas pipeline to Erbil, Chemchemal and Sulaymaniyah (Bazian) power stations. LPG and condensate will continue to be exported by truck on existing roadways.

Some of the KM250A Project facilities will be shared with the existing facility, including produced water treatment, water supply, power generation and fuel supply. Processing at the KM250A Project site will include desulphurisation, dehydration, mercury removal, fractionation and compression in order to meet export product specifications.

Operations will require water (abstracted groundwater) for process purposes, domestic usage and utilities including firewater.

Power for the KM250A Project will be temporarily generated using gas engine driven generators however, a permanent electric power supply from a central power plant based on gas turbine generators is planned in the next phase of plant expansions. Fuel gas will be taken from on-site gas production for hot oil heaters and flare pilots.

Operation of the process equipment at the KM250A Project site will involve routine emissions of combusted gas from hot oil heaters, flare pilots, gas engine driven compressors and generators, thermal oxidiser and incinerator. Fuel gas combustion and hydrocarbon components of waste gases will emit greenhouse gases and the atmospheric pollutants carbon monoxide, nitrogen oxides (NO_x) and sulphur dioxide (SO_2). In addition to fuel gas combustion, the thermal oxidizer will emit SO_2, NO_x and particulate matter. KM250A Project traffic will release exhaust gas.

Other than flaring of small quantities of condensate storage tank vent gas, routine flaring will not occur during operations; however, several non-routine flaring events are planned. Flare systems will be available for use when required and flare pilots will remain lit at all times. A thermal oxidiser will be installed to combust acid gas from desulphurisation; emissions from this unit will include sulphur dioxide.

Vent gas from condensate tanker truck filling operations will be released to the atmosphere (1300 tonnes/year) after mixing with air. Pearl Petroleum is also considering various abatement measures, including flaring and a vapour recovery unit. These options will be further investigated during the detailed engineering phase of the Project. This is expected to be a short-term activity as a new condensate export pipeline to Chemchemal is planned for a future expansion phase at the KM site.

The volumes of produced water (water that is mixed with gas coming from production wells) will be low initially but will increase over time. Produced water shall be treated and discharged to a lined evaporation pond.

Noise will be generated from plant and equipment operation and flaring.

Chemicals and hazardous material will be required during the operations phase; these include diesel, oils (lubricating, hydraulic, transformer), molecular sieve, methanol, water treatment chemicals, and mercury absorbent. Both hazardous and non-hazardous waste will be generated during operations. Some hazardous waste will be stored at the site until management options in the KRI receive certification by KRI authorities. Other hazardous wastes will be managed offsite or incinerated at the site. Most non-hazardous wastes will be recycled offsite or sent to offsite public landfills. All wastes will be managed in accordance with good international industry practice (GIIP).

The operations phase will require 80 to 100 workers, who will travel to the KM250A Project site from the local area or stay at the construction on-site accommodation.

Decommissioning phase

KM250A Project infrastructure will be decommissioned and dismantled once Pearl Petroleum determines that its effective life has been achieved. Specification of decommissioning activities will be developed closer to the decommissioning date and will be in accordance with good international industry practice and local requirements.

Decommissioning and dismantling will be performed by specialist contractors supported by a core team of Project operations staff.

Resource use, air emissions, noise, chemical usage and workload is likely to be similar to construction phase usage. Wastes are likely to be similar to construction waste but will also include plant equipment and materials that could be re-used.

Project alternatives

Pearl Petroleum has considered various technology, process and operating regime alternatives during the front-end engineering and design (FEED) stage of the Project. Final selection of technology and processes will be recommended by the EPC Contractor to Pearl Petroleum once that contractor has been selected. This is to be determined based on:

- potential environmental and social impacts and ensuing that the Project Standards associated with emissions and effluent limits are achieved during routine operations
- occupational health and safety risks to the workforce and process safety risks to local communities
- reliability and operability
- CAPEX and OPEX.

Alternative technologies

Alternative technologies and designs have been considered for various aspects of the Project during the pre-FEED work. The key alternatives considered for the Project are as follows:

- gas dehydration
- use of gas engine drivers for sales gas compression and power generation
- gas desulphurisation
- mercury removal
- disposal of acid waste gas from sulphur removal
- management of vent gas from new condensate storage tank
- export of sales gas.

'Do nothing' alternative

As per KRI ESIA legal requirements and guidelines, the 'Do nothing' alternative also need to be was considered. Under this alternative, no positive or negative environmental or social impacts would be realised. However, the 'Do-nothing' alternative is not a viable option since it would compromise compliance of Pearl Petroleum's commitment to the KRG under the Gas Sales Agreement and, consequently, it would not fulfil the KRG's goals to expand oil and gas exploration and production capacity.

Stakeholder engagement

Stakeholder engagement is an important part of the ESIA process and a national and international requirement. A Stakeholder Engagement Plan (SEP) was developed for the ESIA process and engagements were undertaken to:

- inform stakeholders in an accessible and appropriate manner about the KM250A Project and the ESIA and provide opportunities for them to engage and register grievances
- ensure that stakeholders understand how they might be affected by the KM250A Project and their potential role in impact identification and management
- obtain the input of stakeholders into KM250A Project impact identification and impact management
- provide opportunities for stakeholders to express their opinions and concerns about the KM250A Project and the ESIA and ensure that these opinions and concerns are considered in the ESIA and any related management decisions.

During the disclosure phase of the ESIA, further engagement will be undertaken to provide feedback and obtain comments from stakeholders on the impact assessment and associated management or mitigation measures.

Community stakeholder engagement

Ten community stakeholder engagement meetings, attended by 184 stakeholders, were held in October 2019. The main issues and concerns raised during these meetings revolved around social issues (including employment and community development, land use and worker safety), general environmental impacts, stakeholder engagement and KM250A Project characteristics (for example, security).

Non-community stakeholder engagement

Pearl Petroleum holds regular meetings with the MNR regarding the KM250A Project and general matters. Feedback and input are obtained from the MNR, particularly on key issues such as social impacts, water and waste. The MNR has advised waiting until disclosure before holding further non-community engagement meetings, at which point a selection of other government ministries and other non-community stakeholders will be contacted to discuss the Project.

Environmental and social baseline studies

The baseline studies were conducted using a combination of secondary data (desktop studies and data collected by others) and primary data (field surveys). The desk-based portion of the baseline study was undertaken through a review of available documents and data sources. Environmental field surveys were undertaken in cases where existing data and information were deemed insufficient for soil quality, groundwater quality, noise, air quality and biodiversity. The new field data ensure that local data and information are up to date. Social baseline surveys were undertaken in conjunction with the stakeholder engagement process (see above). Areas of influence (AOI) were defined for various topic areas. They represent the geographical area expected to be affected by:

- impacts (direct and indirect) arising from Project activities and facilities (this includes the Project site, flowlines and road transport network used for the transportation of personal and materials)
- impacts from unplanned, non-routine events
- indirect impacts on biodiversity or on ecosystem services that are linked to the livelihoods of affected communities
- associated facilities consisting of five new production wells
- cumulative impacts.

The Project AOI was used to guide baseline development and provide focus for ESIA baseline activities.

ESIA findings for planned activities

Planned activities are either those that correspond to routine or non-routine operations of the KM250A Project. Routine operations concern normal functioning of all plant processes. Non-routine operations concern response to upsets at the plant requiring flaring or blowdown to avoid overpressure, or minor spills or leaks that only affect the immediate process area. Non-routine events will be minimised through implementation of controls developed and implemented by the KM250A process safety team.

The main findings of the ESIA are related to soil, water resources, air quality, noise, biological environment and social (including socio-economic) impacts. These are topics where un-mitigated impacts have been identified as significant, and some level of residual impact are expected. Mitigation measures are included where impacts have been rated as significant. Opportunities to maximise positive impacts have also been identified.

An environmental aspect is ‘an element of an organisation’s activities, products or services that can interact with the environment’ (International Standards Organisation 14001). In the ESIA, an ‘aspect’ of the proposed activities that can cause changes to the environmental and social baseline conditions has a possible ‘impact’.

The identified impacts are assessed according to the following criteria and associated scores:

- the magnitude of impact
- the sensitivity of impact.

The significance of an impact (rated major, high, moderate, minor, slight or positive) is a function of the magnitude of the impact and sensitivity of the potentially affected receptor(s).

Where necessary, mitigation measures have been proposed to further reduce the potential impact to ALARP (as low as reasonably practicable) or to maximise any potential benefits.

The following sections present results in terms of impacts that were derived based on various criteria specified in the ESIA report, baseline conditions, and KM250A Project activities and infrastructure. Discussion only concerns impacts rated as significant (that is, moderate or higher).

Soil

Soils within the Project area are characterised by rough broken and stony land or brown silty clay to sandy clay soil with high pH (8.1 to 8.5) and high electrical conductivity. The presence of organic matter in the soil is low but supports agricultural activities such as livestock rearing and crop farming.

Soil samples were collected by RSK in November 2019 at 13 locations. None of the concentrations of analysed parameters exceeded the Project Standards, except for nickel, which may represent background soil composition.

The KM250A Project is expected to lead to insignificant (minor to slight) residual impacts on soil quality during all Project stages, and allow **full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below 'significant'**.

Water resources

The Awa Spi river, the only perennial river in the general Project area, flows to the south-west/west. At its nearest, the river runs approximately 3.5 km from the existing KM facility, which is outside of the surface water area of influence for the KM250A Project. The Awa Spi has three tributaries; these and other surface water features within the general Project area are seasonal. Additionally, there are several springs present within the AOI.

Previous groundwater sampling and analysis in the Project area (conducted in 2010 and 2018) showed concentrations of some parameters exceeding the Project Standards at some locations in the Project area. In particular, bacterial contamination exceeding Iraqi standards has been identified at many locations.

In November 2019, RSK conducted groundwater sampling at 13 wells and springs in the AOI. The results indicate the presence of total coliforms at all locations exceeding the Project Standard. At Zhazh Spring, concentrations of chloride, sulphate, total dissolved solids, magnesium and calcium exceeded the Project Standards. Calcium concentrations exceeded the Project Standards at several locations. No further exceedances were detected; the presence of other analysed parameters, including *Escherichia coli* and hydrocarbons were not detected.

The significance of Project impact on groundwater resource abstraction leading to aquifer drawdown was rated as high. The significance of Project impact on problems with storage and handling of fuels and chemicals leading to leaks/spills and thus reduced groundwater quality was rated as moderate. The following proposed mitigation measures bring impact significance ratings down to minor in both cases:

- development of a Water Management Plan to ensure the sustainable management of water resources.
- refuelling at designated areas in accordance with industry guidelines.
- storage of chemicals and hydrocarbons within secondary containers in accordance with industry guidelines.

These mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below 'significant'.

Noise

Noise monitoring was undertaken by RSK in August 2019 in the vicinity of the proposed KM250A Project site and at nearby communities within the noise AOI. The results show that ambient day-time noise levels were below the Project Standard residential limits and were typical of rural areas with some domestic and commercial activities. Average night-time residential noise levels exceeded the Project Standard at one location. The day-time industrial Project Standard was exceeded at two industrial locations at the KM site fenceline.

Quantitative noise assessments and modelling were undertaken for construction and operations phases of the KM250A Project based on Project activities, traffic movements and setback distances. Night-time noise levels generated by the Project were predicted to result in high impact significance.

Noise mitigation measures are expected to include, but not be limited to:

- the adoption of quiet working methods, where practicable, using plant with lower noise and vibration emissions.
- avoiding or limiting noisy construction activities at night.

These mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below 'significant'.

Air quality

Air quality levels in the KRI are known to be degraded primarily due to industrial and petroleum operations in the region. RSK conducted a baseline air quality monitoring survey (diffusion tubes were deployed for 30 days) in August and September 2019 at eight locations within the AOI. Existing baseline concentrations of sulphur dioxide (SO_2) and volatile organic compounds (VOCs) exceeded the Project Standard at some locations.

The KM250A Project is expected to lead to insignificant (minor) residual impacts on air quality during all Project stages.

Due to the substitution of KM250A Project sales gas in regional power plants that would otherwise require diesel fuel for generation, decreases of emissions are expected to contribute to improvements of regional air quality, and decreases in greenhouse gas emissions.

Impacts on air quality during the operations phase was predicted via an atmospheric air dispersion modeling study conducted by RSK for routine and non-routine operations. The model showed an exceedance of the Project Standards and/or WHO/IFC interim limit for the 1-hour averaging period for nitrogen dioxide (NO_2) maximum offsite concentrations and for the 1-hour, 3-hour and 24-hour SO_2 maximum offsite concentrations. However, the 95th percentile offsite concentration for $N0_2$ (1-hour) and SO_2 (24-hour) did not exceed the Project Standard or interim limit, respectively

In the case of NO_2, the exceedance can be attributed to the combined effects of all point sources operating at the same time. In the case of SO_2, the exceedance is almost entirely caused by emissions from the thermal oxidiser, which oxidises acid gas (containing hydrogen sulphide, H_2S) from the amine desulphurisation unit. The elevated SO_2 concentrations in the exit flue gas is because of high hydrogen sulphide in the feed sour gas to the unit.

Pearl Petroleum is committed to meeting the KM250A Project Standard for SO_2 and NO_2 emissions. Furthermore, the EPC Contractor is contractually obliged to meet the Project Standards. Taking guidance from the World Health Organisation ambient air quality guidelines (adopted by IFC, 2007), Pearl Petroleum will take a stepped-approach to meet the interim targets and guideline values, closely monitoring and reviewing the design deliverables to ensure compliance, with a focus on the thermal oxidiser. At the 95th percentile, operations will comply with the WHO/IFC interim target 1, which is equivalent to the KRG standard.

Further evaluation of compliance solutions (such as a sulphur recovery unit, flue gas scrubbers, thermal oxidiser design specifications, caustic wash) will be undertaken during the detailed engineering phase. The air quality model will be re-run with detailed design specifications to confirm compliance with the Project Standards. Pearl Petroleum is confident that this stepped-approach will result in compliance with the Project Standards.

Air quality mitigations are expected to include:

- further evaluation during detailed engineering, procurement and construction stage and additional air quality modelling
- installation of alternative treatments for sour gas and evaluate compliance solutions during the detailed engineering phase.

These mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below 'significant'.

Biological environment

The KM250A Project site is not located within or near any nationally or internationally designated protected areas for biodiversity. The closest designated area for biodiversity is the Chemchemal Key Biodiversity Area and Important Bird Area, which are located approximately 12 km south-west of the KM250A Project site.

An ecology survey of the AOI was conducted by RSK and Kurdish biologists familiar with the biodiversity and ecology of the area in October 2019. The survey included placing trail cameras and recording bat calls. The results of the survey provided an overview of species presence and an understanding of the habitats within the KM250A Project area. This was used to supplement existing biodiversity information from previous surveys at Khor Mor and online resources.

The majority of the habitats located within the ESIA survey area are categorised as modified habitats including agro-pastoral land (predominantly cropland), scattered scrubs, unsurfaced roads, cleared ground and urban settlements. Natural habitats comprising steppe grassland, an ephemeral stream and a small pond were also found. The significance of the following potential impacts were rated as moderate:

- direct permanent loss of ecologically significant habitat and vegetation and fragmentation of breeding and foraging habitat
- temporary loss of ecologically significant terrestrial habitat and vegetation soil erosion or compaction resulting in poor re-establishment of vegetation within flowline rights of way and other temporary construction phase facilities (for example laydown areas)
- noise and disturbance to fauna
- direct mortality of species from collisions with equipment and vehicles
- inadvertent chemical spills leading to habitat loss and injury/mortality of flora and fauna from food and surface water contamination

- reduce the time between construction and reinstatement for works undertaken in sensitive habitats to the extent possible
- disturbance from noise and vibration from people using the office area.

A critical habitat assessment was conducted as part of the ESIA that included consultation with various experts (Nature Iraq, University of Sulaymaniyah and Polytechnic University of Sulaymaniyah). Impacts on all of the critical habitat qualifying species were considered to be insignificant (minor or slight) and no biodiversity offsetting/net gain is required.

While the habitats within the AOI are considered to have low conservation importance, the habitat may support endangered or critically endangered species. A number of species and habitats were considered. It was concluded that the habitat of these species and their possible presence at the Project site are unlikely to be affected by KM250A Project activities.

Biodiversity or ecology-related mitigation measures are expected to include the following, thus bringing all impact significance during all phases to minor:

- preparation of a Biodiversity Management Plan
- undertaking a pre-construction survey for important plant species in areas identified as potential habitat in particular along flowlines where routes are likely to be re-surveyed
- evaluating practical alternatives to avoid or reduce impacts to the important plant species if these species are identified within areas subject to land disturbing activities
- undertaking site clearance with due consideration to main breeding season
- limiting vegetation removal to the extent possible
- reducing the time between construction and reinstatement for works undertaken in sensitive habitats to the extent possible
- undertaking toolbox talks with staff to educate them on what species are likely to be present on-site and on correct actions to be taken if any animals are encountered
- the development and implementation of a Lighting Plan for the new and existing facilities to limit spread by using directional lighting, hoods etc and only light the working areas
- develop and implement vehicle maintenance program to manage gaseous emissions from vehicles
- limit driving to designated routes
- design permanent truck route to avoid sensitive habitats
- limit office operations to daylight hours, where possible.

These mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below ‘significant’

Social and social-economic environment

To inform the social baseline for the ESIA, existing reports and publicly available information were collected from various sources to provide contextual information at the regional and governorate level. This was followed by the collection of quantitative and qualitative primary data on local communities by RSK and a team of Kurdish social consultants between September and November 2019 through 145 household interviews, focus group discussions with flowline land users and women, key informant interviews with village leaders (Anjuman) or Sub-District Managers, schools and health facilities. Visual observations of road conditions, traffic volumes, land use and an archaeology and cultural heritage walkover survey were also undertaken.

The KM250A Project is expected to lead to the following positive impacts on the socio-economic baseline during construction and operations:

- opportunities for local and regional businesses to supply goods and services to the KM250A Project, generating multiplier effects across the local economy
- direct employment and skills development through training
- contribution of the KM250A Project to the development of Kurdistan's oil and gas sector through regional economic growth.

Such positive impacts will be maximised where possible.

The following mitigation measures, presented by topic, were applied to social/socio-economic impacts with significant (moderate or higher) impact ratings:

Local economy

- prioritise the sourcing of goods and services from local and regional businesses, providing required quality and delivery timescales can be met
- support the development and capacity building of local and regional businesses, either directly or as part of government of sector-wide initiatives
- develop an influx management strategy (including a 'no hiring at the gate' policy), providing clear information on the scale, scope and process of accessing Project-related employment and business opportunities
- implement a comprehensive Social Monitoring Plan that includes monitoring socio-economic changes in local communities (e.g. in living standards, household well-being and other daily necessities) through regular community meetings and through regular price surveys

Employment and skills development

- provide on-the-job training to the Project workforce in order to enable workers to gain new or improved skills and provide formal recognition of this training (e.g. through references and/or certifications) to workers where possible
- where appropriate, develop a Local Community Employment Plan (LCEP), prioritising the employment of people from local communities, followed by people from other parts of the Kurdistan Region
- during the recruitment process, and for the duration of their employment, be transparent about the temporary nature of workers' employment on the Project and regularly remind workers of this fact

Land access and livelihoods

- develop and implement a Livelihood Restoration Plan (LRP) to address the short- and long-term economic impacts from temporary and permanent (life of Project) loss of access to land
- undertake regular meetings with village Anjuman and local communities to ensure that information about the Project's land acquisition and compensation strategy is clearly communicated and that stakeholder concerns are effectively addressed
- undertake pre-construction surveys to identify any watering wells and pasture land to which access must be maintained

Community safety and security

- identify risks in health and safety plans and work management procedures and, within this, include provisions to ensure community safety, including safety barriers (e.g. fences) around open excavations to prevent local communities and livestock from falling into trenches

- develop and implement a community safety awareness campaign in local communities with focus on high-risk groups (e.g. children), potentially involving school visits to raise awareness on road safety risks
- where appropriate, develop a work-specific Traffic Management Plan (TMP) which identifies sensitive social receptors along transportation routes and outlines mitigation measures (for example speed limit restrictions, vehicle maintenance activities, awareness campaigns, recruitment of traffic wardens) to reduce the risk of road traffic accidents occurring
- develop and implement workers' codes of conduct, inclusive of training for all Project personnel on local customs, culture and tradition
- review established arrangements for security provision at the existing facility to ensure that they are sufficiently robust to manage security issues which may arise as a result of the Project (make changes to existing arrangements as appropriate)

Infrastructure and services

- monitor water supplies in local communities against baseline conditions; integrate the monitoring plan into monitoring plans implemented at the existing facility

Vulnerable groups

- develop and implement a gender inclusion strategy containing various measures to promote the inclusion of women in the Project.

Application of the mitigation measures and accepted international practices result in manageable risks vis-à-vis sensitive receptors in relation to lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards.

ESIA findings for unplanned events

An unplanned event is defined as a reasonably foreseeable event that is not planned to occur as part of a project, but which may conceivably occur as a result of project activities (e.g. accidents), even with a low probability. Unplanned events may occur during any phase of a project. The risk assessment is based on application of experience of events or incidents to predict risk in the future. Consequences of potential impacts are first determined using severity levels and definitions.

The KRG requires that the impact of unplanned events on public health and safety and the likelihood of their occurrence be taken into consideration, including:

- traffic likely to be generated, including the impact of increased traffic on the local communities as well as the level of risk and methods of prevention of oil spills on roads and highways
- fugitive emissions and unplanned gas releases (by flaring)
- fires, spills, or other accidents.

Unplanned events at KM250A (Phase 1 of KM500 expansion) were identified and assessed by Hatch in the following studies executed during the basic engineering phase of the KM500 expansion project:

- Hazard Identification study
- Central Processing Facility Fire & Dispersion Hazard Analysis
- Hazard and Operability study.

A number of unplanned events, mainly relating to the release of process hydrocarbons, were identified. The assessment showed that thermal radiation and explosion overpressure impacts from these events are contained on-site.

Four consequences of the unplanned events were considered to have the potential to result in offsite impacts, should these events occur:

- noise and visual impact from flaring (flaring is a planned mitigation measure for an on-site gas release and some major process upsets)
- decreased air quality due to smoke from a pool fire
- harm to flora or fauna and/or an odour impact at local communities due to low concentrations of H_2S (toxic gas)
- loss of services provided by Pearl Petroleum to local communities due to a plant shutdown following a major process release or major process upset.

Cumulative impacts

Cumulative impacts result from the incremental impact from other existing, planned or reasonably defined developments. Cumulative impacts for the KM250A Project may occur during further expansion of the Khor Mor site. Although details regarding the potential configuration (and thus impacts) of future expansion projects are not currently known, the likely adverse impacts are as follows:

- increased air emissions
- increased groundwater consumption
- increased local traffic
- increased pressure on Pearl Petroleum Khor Mor waste management facilities
- additional pressure on habitat and biodiversity via installation of additional flowlines.

Positive impacts include the ability to recruit construction workers for future projects as a partial solution to retrenchment, and increased use of local goods and services (including labour).

Associated facilities

Five production wells will be developed in association with the KM250A Project. A comprehensive separate ESIA will be developed for these facilities in late 2020. A high-level impact assessment was developed based on baseline information collected for this (KM250A Project) ESIA, on the existing ESIA undertaken for wells KM9, KM10 and KM12 by MapCom (2018), and on RSK experience with onshore oil and gas drilling. High-level mitigation measures (similar to those described for the KM250A Project) were identified for impacts that may be significant. These potential impacts and mitigations will be further evaluated as part of the ESIA specific to the five wells.

Environmental and social management

Pearl Petroleum is committed to control or reduce potential impacts. The KM250A Project Health, Safety, Security Environmental and Social Performance Management Plan (HSSE&SP MP) includes various safeguards, measures and plans and outlines the mitigation measures and commitments made as part of the ESIA process. The KM250A Project HSSE&SP MP will extend through all phases of the KM250A Project and is intended to inform Pearl Petroleum and contractor personnel of their roles and responsibilities in delivering the KM250A Project. Implementation of the HSSE&SP MP, including any mitigation measures listed in the Commitments Register, will be undertaken within the framework of the Pearl Petroleum HSSE&SP Management System.

1 INTRODUCTION

This document is the Environmental and Social Impact Assessment (ESIA) report for the first 250 million standard cubic feet per day (MMscfd) train for the KM500 gas treatment plant expansion (the ‘KM250A Project’ or ‘the Project’) and has been prepared in accordance with legal and regulatory requirements of Iraq and the Kurdistan Regional Government (KRG).

This ESIA was based in part on the findings of desktop research concerning existing data and information, and supplemental field surveys conducted to date. Stakeholder engagement has been undertaken to supplement the existing studies and further reduce uncertainties ahead of the detailed engineering, purchasing and construction phase of the KM250A Project. The ESIA was also based on the details of Project activities (the Project description) and modelling (concerning operations phase air emissions and noise). All analysis took into consideration the selected Project Standards.

1.1 Operator's name and contact information

Contact information for the key Operator’s personnel are presented in Table 1-1.

Table 1-1 Operator’s name and contact information

		Personnel	Title – Contact details
Project Title	ESIA for first 250 MMscfd Train for Khor Mor 500 Gas Treatment Plant in the Kurdistan Region of Iraq		
Operator’s name	Pearl Petroleum Company Limited	Stuart Harrower	Corporate Head of HSSE (Sharjah) E-mail: sharrower@crescent.ae Tel.: +97165070454
		Matthew Brown	Construction HSE Manager for KM500 (Khor Mor) E-mail: mbrown@crescent.ae Tel.: +9647707702964 (Khor Mor 24-hour Movcon Command)
		Steven Bungay	Social Performance Field Manager (Khor Mor) E-mail: kmspfieldmgr@crescent.ae Tel.: +9647707702964 (Khor Mor 24-hour Movcon Command)
		Mark Mincheau	Senior HSSE Manager (Erbil) E-mail: MMinchaeau@crescent.ae Tel.: +9647712321984

1.2 Key personnel – environmental consultant

This ESIA has been prepared on behalf of Pearl Petroleum Company Limited (‘Pearl Petroleum’) by RSK Environment LLC (RSK), 902 Silver Wave Tower, Mina Road, PO

Box 45103, Abu Dhabi, United Arab Emirates. In 2017, the Iraq Ministry of Health and Environment accredited RSK as an advisory office for environmental consultancy and RSK is an approved supplier with the KRG Ministry of Natural Resources (MNR). Contact details for RSK is presented in Table 1-2.

Table 1-2 Environmental consultant contact details

Name	Address	Personnel	Title activity
RSK Environment LLC	P.O. Box 46211 Abu Dhabi United Arab Emirates Tel: +971 2 611 8500 Fax: +971 2 627 5764 www.rsk.co.uk	Robert Gould Cyndi Teulon Grace Rigby Corin Simmonds Abraham Jacob Hamdi El-Ghonemy Daniel Clare Zhanar Zhakeyeva Ruth Brooker Corinne Kennedy Mark Underhill Lucinda Knight Jessica Hommelhoff Ruba Farkh	Environmental consultants - ESIA experts

2 DESCRIPTION OF THE OPERATIONS AND ACTIVITIES

This section presents a description of all aspects of the Project that is the subject of this environmental and social impact assessment (ESIA).

2.1 Background and project purpose

The existing Pearl Petroleum Company Limited (hereafter to be referred to as Pearl Petroleum Khor Mor (KM) facility, located in the Sulaymaniyah Governorate, in the Kurdistan Region of Iraq (KRI), was constructed from 2007 to 2011 and comprises a gas plant and liquified petroleum gas (LPG) extraction facilities that produce sales gas, LPG and condensate from the KM reservoir. The facility is sited within an overall fenced Development Area of 600 hectares (ha), approximately 50 ha of which is currently occupied.

Sales gas from the existing facility is exported via a 24-inch (“) pipeline to power stations in Chemchemal, Sulaymaniyah and Erbil, respectively 65, 70 and 180 kilometres (km) from the site. As the only gas supplier to regional power stations, Pearl Petroleum provides a clean and highly cost-effective alternative solution to diesel-fuelled power generation.

Pearl Petroleum is planning the expansion of its existing KM gas processing facility. The Project is part of longer-term development plans to increase gas production at KM. The KM500 Expansion Project (concerning the first 250 million metric standard cubic feet per day (MMscfd) of increased gas capacity, (‘KM250A’) is a natural extension to the existing project at the KM gas field and will continue to provide benefits through natural gas to the Kurdistan Regional Government (KRG) under a Gas Sales Agreement and additional condensate and LPG sales into the local market.

The KM250A Project will increase production of sales gas, condensate and LPG products at the existing facility, thereby contributing to the KRG’s goal of expanding oil and gas exploration and production capacity in the region. The Project comprises engineering, design, procurement, construction, operation and eventual decommissioning of a new gas processing facility (within the existing site boundary) as well as up to five additional flowlines from new gas field production wells to the processing facility and new access roads (external to the site boundary).

2.2 KM250A Project schedule

The indicative KM250A Project schedule is presented in Table 2-1.

Table 2-1 Key project activities

Activity	Estimated date
Early works	Q3 2019 to Q3 2020
Start of construction works for KM250A	End Q2 2020
Commissioning	End Q4 2021 to Q1 2022
Operations (first gas) at KM250A begin	Q1 2022

2.3 Project location and site description

The KM field is located in the KRI, approximately 50 km to the south-east of Kirkuk. Figure 2-1 illustrates the Project location. Figure 2-2 is a view of the whole KM area, including the Expansion Area (the area that will be allocated to the KM250A expansion). Figure 2-3 presents the site plan schematic, including the existing gas plant and the main parts of the site to be utilised by this project (the Expansion Area, the Development Area and the Offsites Area).

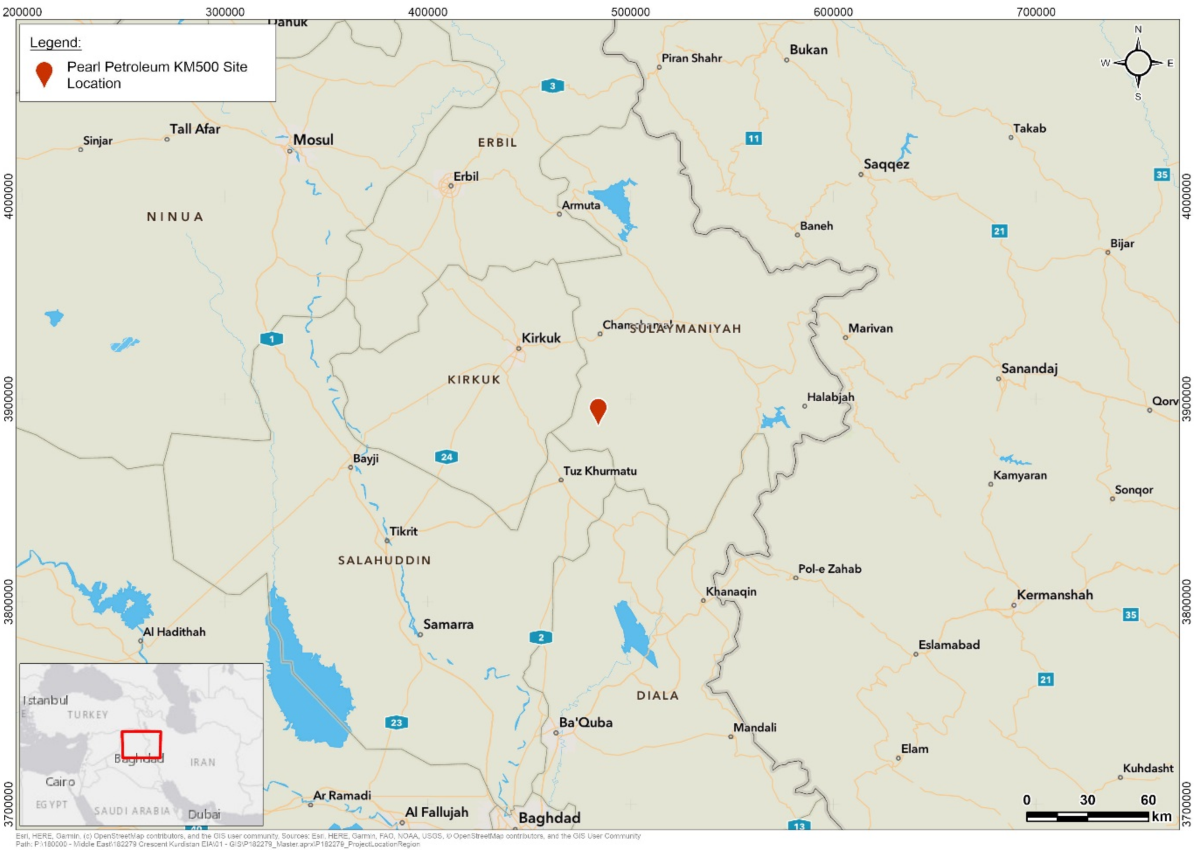


Figure 2-1 KM location

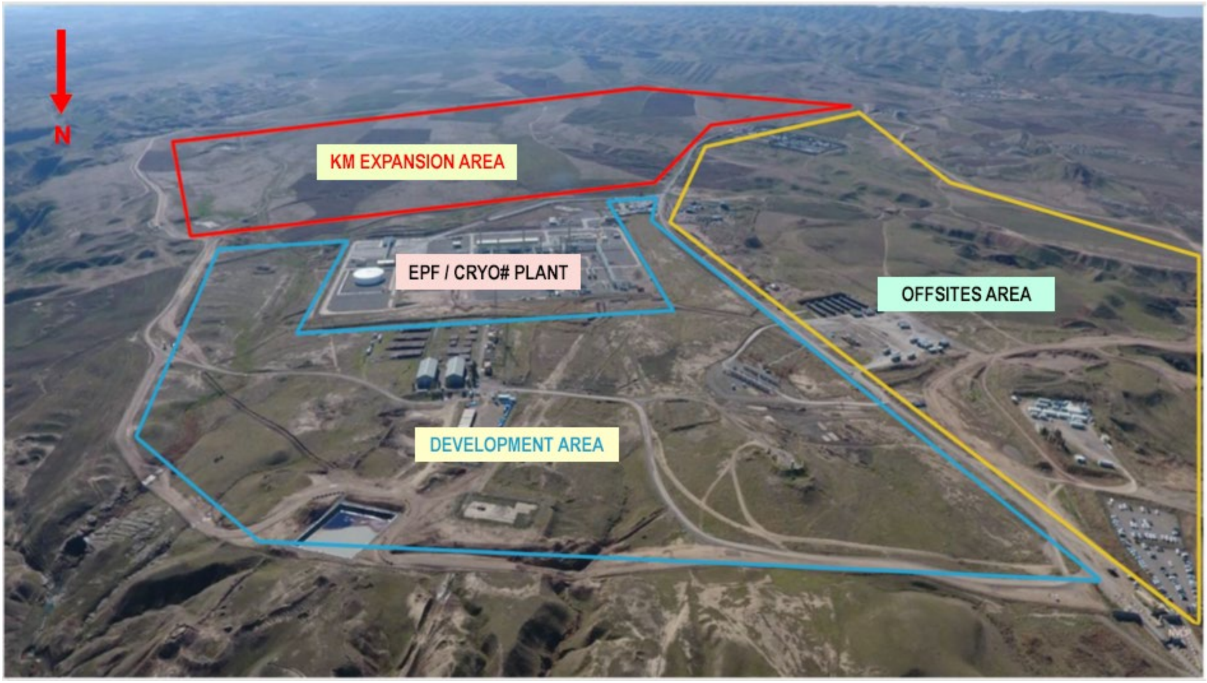


Figure 2-2 KM area

Source: Pearl Petroleum

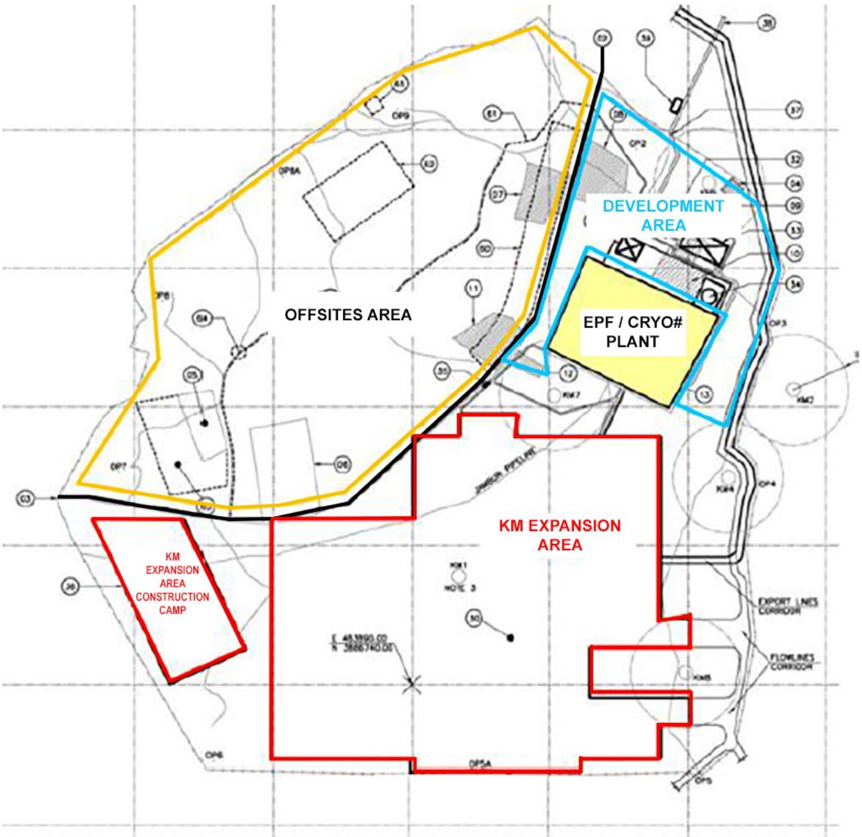


Figure 2-3 KM site plan

Source: Pearl Petroleum

2.4 Current activities at the site

The existing site contains a gas plant and LPG extraction facilities that produce sales gas, LPG and condensate from the KM reservoir. The facilities occupy approximately 50 ha within an overall fenced area of 600 ha, and consist of:

- two parallel LPG extraction trains ('Cryo#') (150 MMscfd sales gas capacity each)
- early production facility (EPF) (120 MMscfd sales gas capacity)
- condensate stabilisation, storage and export (13,000 barrels per day – bpd - nominal)
- LPG storage and truck loading (1,020 metric tons per day nominal)
- sales gas compression for LPG recovery trains and export by pipeline
- utilities.

Figure 2-4 shows existing KM production wells and flowlines. The gas plant is fed by gas from the original production wells (KM3, KM4, KM5, KM6, KM7 and KM8) within or near the KM site. KM9 has just been brought online. KM10 and KM12 have been drilled and suspended; there are currently no plans to tie these into the gas plant. KM14 is a potential appraisal well that has not been drilled yet.

The existing production well flowlines are buried at 1 m depth. The routings have been extracted from a general site plot plan and will be confirmed via site survey during the detailed project design phase by the engineering, procurement and construction (EPC) Contractor. An underground survey has been commissioned by Pearl Petroleum. The existing flowlines are routed to the north-west corner of the existing Cryo# plant.

As mentioned earlier, the main four areas (as shown in Figure 2-2) within the KM fenceline are:

- existing EPF and Cryo# Plant
- KM Expansion Area (to the south of the existing EPF/Cryo plant)
- Development Area
- Offsites Area.

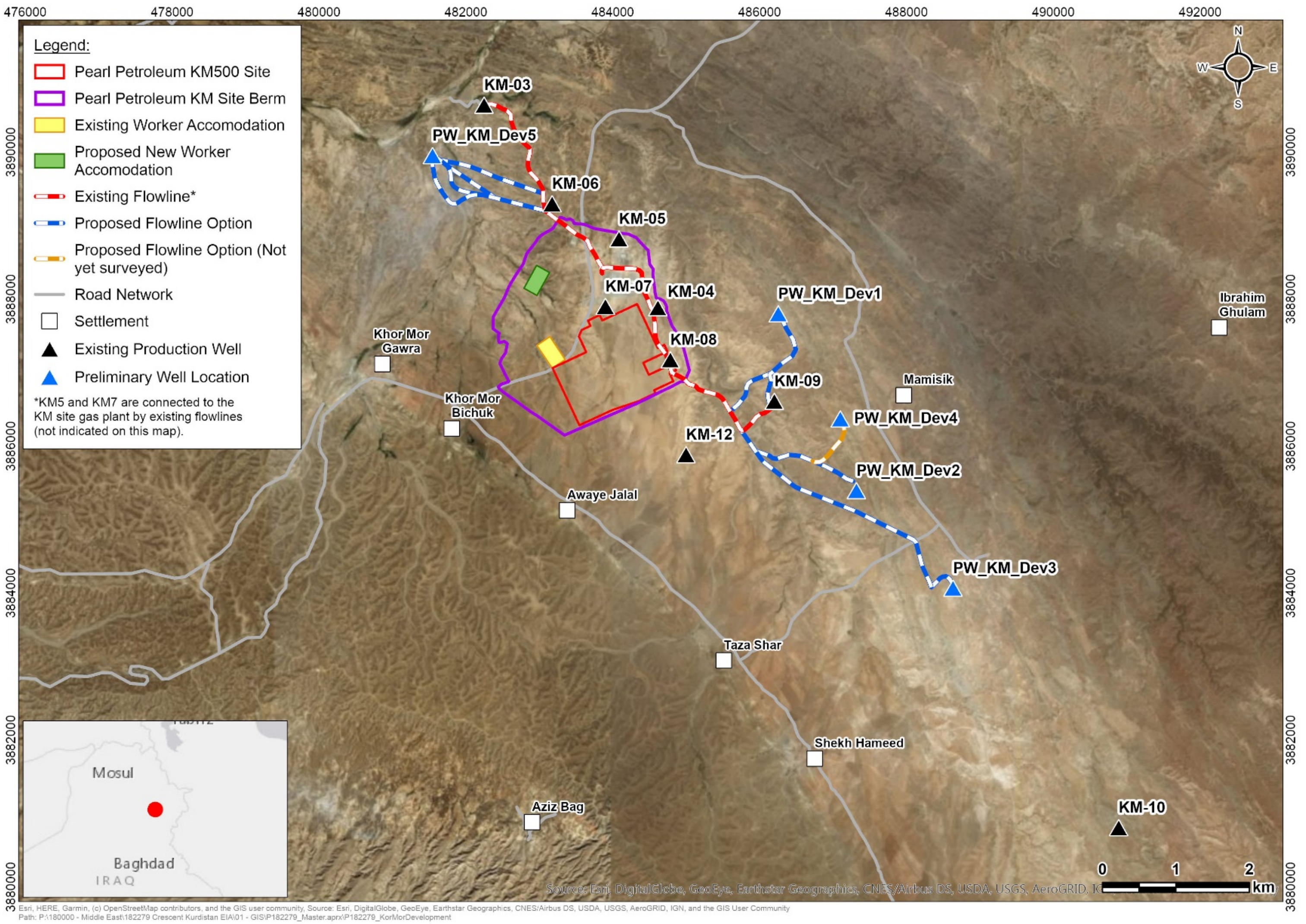


Figure 2-4 Location of existing and proposed future KM production wells and flowlines

2.5 Description of KM250A Project

2.5.1 Introduction

Pearl Petroleum intends to conduct a phased development of the existing gas plant with capacity initially increased by debottlenecking of the EPF, which was completed in Q4 2018. The first phase (KM500 project) is to add a nominal 500 MMscfd of sales gas export and 26,000 bpd of condensate export with two 250 MMscfd gas trains. These gas trains will be phased with the first 250 MMscfd train (KM250A) to be completed in 2022. The proposed KM250A Project (the subject of this ESIA) involves engineering design, procurement and construction of a gas processing facility capable of producing sales gas, LPG and condensate within the existing 600 ha site via the first of two gas treatment trains. Up to five additional flowlines (from up to five new production wells) external to the site boundary will also be required.

For the first 250 MMscfd gas train, sales gas will be routed through the existing 24'' sales gas pipeline to Erbil, Chemchemal, Sulaymaniyah (Bazian) power stations. Liquified petroleum gas (LPG) will continue to be exported by truck. Condensate will continue to be transported by truck and/or pipeline to Jambur.

Some of the existing facilities will be used in the KM250A Project, and there will be tie-ins with the existing facilities. The Project will also include

- new flowlines
- rerouting of the existing condensate export pipeline to Jambur.

Construction is anticipated to start end of Q3 2020 with completion and first production of gas/liquids by the end of Q1 2022.

2.5.2 Project components

The main components of the project are the following:

- new wells (not part of this ESIA)
- inlet separation
- amine unit for the gas desulphurisation
- amine regeneration unit
- molecular sieve dehydration unit
- dehydration regeneration unit
- mercury removal
- natural gas liquid (NGL) recovery
- de-ethaniser overhead compressor
- debutaniser
- condensate stabilisation feed separator
- flash gas compressor
- condensate stabiliser
- KM250A tie-ins with the existing pipelines
- thermal oxidiser
- additional condensate storage
- sales gas/booster compressors.
- new condensate tanker loading facilities.

2.5.3 Expansion Area

The Expansion Area is about 1.5 km by 1.5 km. The main KM250A gas processing facility, which will be located within the Expansion Area, will comprise

- new production manifold and test manifold
- common new reception facilities (new gas/liquid separator, hydrocarbon liquid/water separator and test separator)
- one 262.5 MMscfd gas processing train (KM250A) consisting of the following unit operations:
- de-ethylamine (DEA) unit for gas desulphurisation
- molecular sieve gas dehydration units
- mercury removal unit
- gas dew pointing and LPG recovery unit
- de-ethaniser and debutaniser to refine NGL to raw LPG to supply the local market
- common condensate stabilisation unit
- common flash gas compression.

In addition to the gas processing plant and the new flowlines (as mentioned above), the KM Expansion Area will also include the following developments:

- flares
- central control building and laboratory
- utilities and central power generation area
- KM Expansion Area project offices, construction workshops/yards/laydown areas, designated muster areas and the construction accommodation camp.

The section of the existing condensate export line to Jambur located within the site perimeter fence will be rerouted as part of the Project.

2.5.4 Development Area

The key features of planned Project activities within the Development Area include decommissioning of various existing facilities, especially

- the warehouse and laydown area (Offsites Area)
- the evaporation pond (water will be transferred to the Expansion Area evaporation pond).

Other changes include

- addition of a new condensate storage tank that will accommodate future expansion
- addition of temporary compression capacity for KM250A sales gas and temporary booster compression for EPF/Cryo# sales gas
- metering package for KM250A sales gas prior to injection into the existing 24” sales gas pipeline
- new metering package and coalescer for EPF/Cryo# sales gas
- new condensate truck loading facilities and associated infrastructure including:
    - decommissioning of existing NGL truck loading
    - a new dedicated east vehicle checkpoint (VCP) for LPG and condensate trucks with associated security infrastructure

- new truck weighbridges or incoming trucks, two for outgoing trucks
- new truck access roads including new road to the LPG loading facility.

2.5.5 Tie-ins

As mentioned earlier, the Project requires various tie-ins to the existing facilities for the gas processing operations and transportation of the sales gas, condensate and LPG. The main tie-ins are shown in Table 2-2.

Condensate tie-ins and facilities will allow

- combined storage of condensate from KM250A and existing operations in the existing and new condensate storage tanks
- Cryo# and KM250A condensate export to a new condensate truck loading facility (located in the Development Area)
- KM250A condensate export to the existing Jambur export pipeline (a short section of this pipeline within the site perimeter will be re-routed to run just north of the KM Expansion Area footprint)
- tie-ins to storage and export facilities planned in future expansion phases.

Tie-ins will allow the use of Cryo# plant selected utilities and services to support the tie-ins described above such as firewater, instrument air and fuel gas. Transfer of EPF/Cryo# plant control from the existing control room to the KM central control building (located in the KM Expansion Area) will be implemented.

Table 2-2 KM250A tie-ins

Fluid line	Description	Line size
Sales gas	Pipeline to Chemchemal and Erbil	24”
Condensate	Pipeline to Jambur	20”
LPG	KM250A to existing LPG storage and truck export (LPG storage manifold)	-
Raw water	Underground pipe from Offsites Area	To be agreed during detailed design phase
Potable/domestic water	Underground pipe between KM Expansion Area	To be agreed during detailed design phase
Sanitary waste	Underground pipe from Offsites Area from KM Expansion Area	To be agreed during detailed design phase
Stormwater	KM Expansion Area to east catchment area	-
Electric power	KM500 main electrical substation to Offsites Area	(2) 6 kV cables

2.5.6 Process description

2.5.6.1 Production wells, flowlines and inlet gas separator

Up to five additional production wells will be required for the KM250A Project; these will be the subject of a separate ESIA and therefore are not covered in this ESIA. The proposed new wells for the KM250A Project (currently estimated as five in number) are all within a few kilometres of the site. New 10” flowlines (that are within the scope of the current ESIA) will bring additional gas to the site from new production wells.

For the KM expansion a northern and southern flowline/trunk line corridor will be established. The southern flowline/trunkline corridor runs approximately 20 m inside the existing site eastern perimeter fence. This will allow installation of a planned security track and inner fence. The northern flowline/trunk line corridor will be inside the export pipeline corridor along the eastern perimeter fence.

KRG and Ministry of Natural Resources (MNR) do not require formal restrictions on access to the flowline corridors/right-of-way (RoW) during flowline construction. Nonetheless, Pearl Petroleum will take precautions to avoid possible risks associated with entry of non-Project personnel to the construction; areas by 1) marking the routes; 2) making concerned parties aware of construction activities within the corridors or below-grade activities (although farming in the area may not be precluded); and 3) conducting frequent inspections along the corridors conducted by dedicated inspection personnel.

At the inlet to each flowline there will be a removable spool to allow installation of a temporary pig launcher to facilitate commissioning and periodic inspection of the flowline. The outlet of the flowline is equipped with a removable spool to allow installation of a temporary pig receiver to facilitate commissioning and periodic inspection of the flowline.

The inlet gas separator is a two-phase gas liquid separator designed for the full KM500 gas processing capacity; it is designed to operate during initial high pressure (HP) operations at 76 barg. Liquid holdup in the separator is not expected; any liquids will drain by gravity to the downstream inlet liquid/liquid separator. The separator separates liquid from the gas stream before the gas is routed downstream for further processing. The separator does not have any slug holdup volume.

The liquid/liquid separator is nominally a three-phase separator, although the vapour space allowed for vapour separation is small, as very little vapour carried over from the inlet gas separator is expected. Any vapour separated is routed back to the inlet gas separator via a balance line.

2.5.6.2 Gas processing

The KM250A Project includes a new gas processing facility that will operate independently from the existing EPF and Cryo# plant. Product export activities from existing operations will be integrated with that from the new plant. Process details are provided in the following sections (see flow diagram in Figure 2-5).

2.5.6.3 Gas desulphurisation

Gas desulphurisation will be accomplished via contact with amine. Raw gas entering the KM250A gas train inlet gas separator will be routed to the inlet gas scrubber and an inlet gas filter/coalescer to minimise carryover of liquids into the amine column (liquids can cause problems with operation of the column). Liquids from the inlet gas scrubber and inlet gas filter coalescer will be routed under level control to the condensate stabilisation feed separator, from which gas will flow to the desulphurisation superheater.

The desulphurisation superheater adds one or two degrees Centigrade of superheat to the gas entering the amine contactor by heating a side stream off the main gas flow (to minimise equipment size). Gas then flows to the amine contactor.

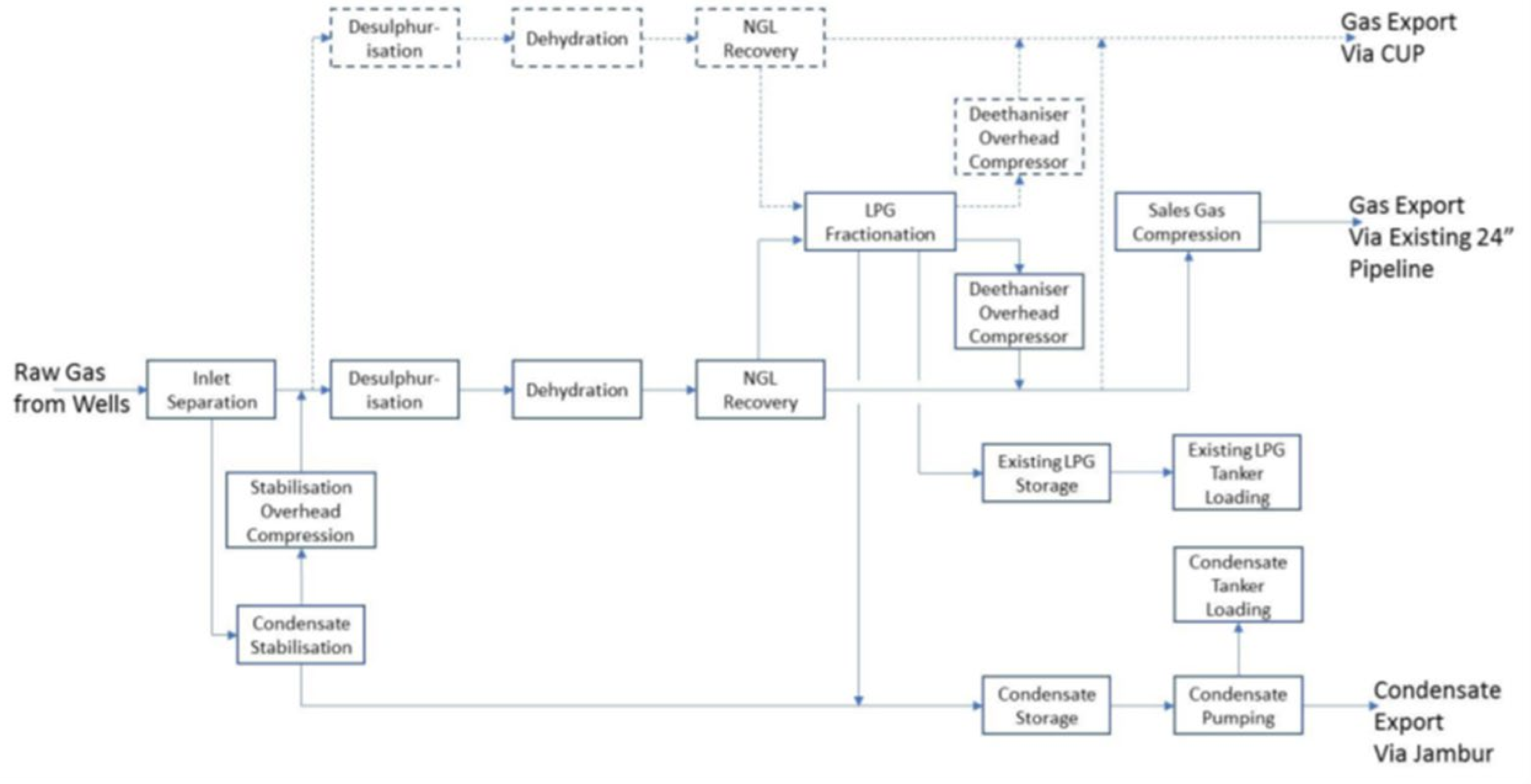


Figure 2-5 KM250A Project gas plant flow diagram

2.5.6.4 *Amine unit*

The amine unit consists of the amine contactor and an amine regeneration system. The amine contactor is a trayed column that uses DEA to remove hydrogen sulphide (H_2S) from the process gas so that the gas export specification can be met and to ensure that downstream equipment does not need to be specified to standards required for H_2S-containing gas streams. The amine contactor has single block valve isolation at its inlet and outlet such that the entire KM250A gas train would need to be depressurised but would not need to be fully de-inventoried for maintenance to be affected on the amine contactor. The contactor has a manual hydrocarbon skim facility to allow any hydrocarbon build up in the vessel to be removed. Liquids (rich amine stream) in the amine contactor are routed under level control to amine regeneration (amine flash drum). Fresh lean (regenerated) amine is fed into the column at the top under flow control.

The amine regeneration system receives H_2S-rich amine from the amine contactor. Its pressure is let down to that of the amine flash drum, which operates at about 5 barg. The amine flash drum also receives liquids from scrubbers and coalescers downstream of the amine contactor that may contain amine carried over from the contactor. Rich amine from the amine flash drum passes through the rich amine filters to remove solids (that can cause foaming) and receives pre-heating by recovery of heat from the hot lean amine stream exiting the amine still using the lean/rich amine exchanger.

Warm rich amine enters the amine still (under level control from the amine flash drum). The amine still treats the rich amine to remove H_2S (and co-absorbed carbon dioxide) with heat provided by the amine reboiler and reflux by the amine reflux condenser air cooler. The H_2S-rich acid gas is routed to the thermal oxidiser (or future sulphur removal package), joining the offgas stream from the amine flash drum.

From the amine still, hot lean amine is pumped back by amine booster pumps via the lean/rich amine exchanger to recover heat. The amine cooler is provided to further cool the amine to the required operating temperature for the amine contactor. The temperature of the amine leaving the air cooler is controlled such that the exit temperature of the amine is 5 to 10°C warmer than the process gas stream entering the amine contactor in order to minimise condensation of hydrocarbons in the amine contactor.

Desulphurised gas leaves the amine contactor and enters the treated gas scrubber which is designed to catch any amine carried over from the upstream contactor to both minimise amine loss and protect the downstream dehydration molecular sieve. The treated gas scrubber is equipped with a water wash system which circulates water to minimise the amount of amine that is lost to the downstream system. The wash system has a single pump as the wash system is not critical to operation of the gas train.

A gas analyser which measures the amount of H_2S in the gas outlet stream will be installed downstream of the treated gas scrubber. There is a spill-off valve to flare downstream of the treated gas scrubber which allows gas to be vented to flare during start-up such that the desulphurisation system can be brought up to minimum flowrate operation and the correct H_2S specification of the gas reached before gas is routed to the downstream systems. The treated gas scrubber includes anti-foam chemical injection points to minimise the risk of amine solution foaming. Make-up water is with weekly batch injection of deaerated demineralised water.

2.5.6.5 *Dehydration and mercury removal*

Dehydration of the desulphurised gas is achieved using molecular sieve beds. Gas flows from the amine unit to a dehydration superheater, which adds one or two degrees of superheat to the gas entering dehydration by heating a side stream off the main gas flow (to minimise equipment size) thereby avoiding liquids condensing upstream and on contact with the molecular sieve beds due to cooling or retrograde condensation (which can cause problems with the beds).

Three molecular sieve beds are to be installed with two beds in dehydration mode via adsorption, dehydrating the gas whilst the third bed is undergoing a regeneration cycle. Each molecular sieve bed is equipped with double block and bleed valves on all inlets and outlets such that a single bed can be taken offline for maintenance without the entire KM250A gas train being taken out of service (although a 40-50% reduction in throughput will be required). The molecular sieve system is designed for the raw gas flow through the plant in addition to the recycled regeneration gas that enters the process upstream of the molecular sieve beds.

Regeneration gas for the molecular sieve beds is taken from downstream of dehydration. Gas is compressed to a high enough pressure to flow through the regeneration system and be recycled back upstream of the inlet of the dehydration inlet coalescer. There are three modes of operation for the recycle gas:

- Regeneration heating: In heating mode the regeneration gas is heated to about 260°C in the regeneration gas heater with the hot gas being routed through the molecular sieve bed being regenerated with the flow routing controlled by automated switching valves.
- Cooling: In cooling mode the regeneration gas is bypassed around the regeneration gas heater. The gas then enters the hot molecular sieve bed thereby bringing the molecular sieve bed down to the normal adsorption temperature.
- Standby: In standby mode regeneration gas is bypassed around the molecular sieve beds (in between other operating modes or switching the molecular sieve bed to be regenerated) such that there is no need to stop/start the regeneration gas compressor and the system runs with a stable operating flow.

After exiting the molecular sieve beds, warm/hot regeneration gas, which is high in water content, is routed through the regeneration aftercooler. After cooling, the regeneration gas is routed to the regeneration knockout (KO) drum to separate the liquid water and gas. Regeneration gas at its water dew point is routed back to the process upstream of dehydration (or to flare if the regeneration gas compressor is bypassed). Removed water is routed to the condensate stabiliser feed separator under level control such that any bulk hydrocarbons are removed prior to the water being routed to the produced water degasser.

Gas next passes to the mercury removal unit (although mercury has not been present in current operations, mercury removal has been included for KM250A). Mercury is removed to avoid:

- damage to the downstream aluminium plate-fin exchanger
- hazards to personnel during maintenance of the downstream cryogenic process.

A mercury guard bed downstream of the molecular sieve beds is used to absorb mercury from the process gas using a non-regenerable absorbent. The mercury guard bed is equipped with a single block valve at its inlet and outlet such that the entire KM250A gas train would need to be depressurised but not fully de-inventoried to affect maintenance on the unit.

All mercury wastes will be managed in accordance with good international industry practice (GIIP).

2.5.6.6 *Liquified petroleum gas recovery*

A heat exchanger will be located upstream of the inlet of the gas dew-pointing system. This exchanger uses cold residue gas returning from the downstream dew-pointing system and cold NGL knocked out in the HP cold separator to pre-cool incoming feed gas before it is let down in pressure to cool further. Gas passing through the warm side of the exchanger will condense some hydrocarbon liquid as it is cooled; this is removed by the HP cold separator.

The recovered cold NGL liquids (after flashing across a level control valve to induce further cooling) are routed to LPG fractionation under level control via the gas/gas/liquid exchanger to recover cooling duty. The gas from the HP cold separator is routed to either the turboexpander or J-T valve for pressure let down to cause further gas cooling. Downstream of the turboexpander or J-T valve the gas is sufficiently cold to meet the sales gas export hydrocarbon dew point, Wobbe Index and Higher Heating specifications after removal of NGL liquids by the low pressure (LP) cold separator.

NGL from the LPG recovery plant (HP cold separator and LP cold separator) is routed to LPG fractionation. In the initial phase of the KM500 project, raw LPG will only be produced for export to the local Kurdistan market, which has a lower specification than required for international export. Liquids from the HP and LP cold separators are routed to the de-ethaniser.

The de-ethaniser is a trayed, single diameter column. Liquids from the HP cold separator are first routed through the gas/gas/liquid exchanger. The de-ethaniser reboiler is a partial kettle type reboiler with an overflow weir. Vapour from the de-ethaniser is routed to de-ethaniser overhead compression, with an option to route part of this stream to LP fuel gas. Liquids from the de-ethaniser are normally routed to the debutaniser. However, if the debutaniser is out of service or zero LPG production is required (for operational reasons) the liquids from the de-ethaniser can be routed to the condensate stabiliser feed separator.

There is a single common debutaniser column to service both KM500 gas trains (that is, the KM250A train concerned by this ESIA and the future KM250B train). Liquids from the de-ethaniser are routed to a common inlet to the debutaniser under level control from the de-ethaniser. The debutaniser is a trayed single diameter column. The reboiler is a partial kettle type reboiler with an overflow weir. Vapour from the debutaniser is routed to an air cooler, which acts as the overhead condenser (total condenser).

Liquid from the debutaniser bottom (condensate product) is routed to condensate export via the condensate inlet heater for heat recovery and the condensate product cooler. Pumps boost the pressure of the debutaniser reflux drum liquid (LPG). Part of this stream is recycled back to the debutaniser column under flow control as the reflux stream to provide cooling flow to the column. The remaining portion is taken off as raw LPG product under pressure control and routed to existing LPG storage.

2.5.6.7 KM250A sales gas export

Sales gas from KM250A will be temporarily exported through the existing 24” sales gas export pipeline to Chemchemal and Erbil, along with gas from the existing Cryo# plants and the EPF. Due to the larger amount of gas being exported through the line the pressure required to enter the pipeline is increased (up to 104 barg) dependent on the total gas export rate, Chemchemal to Erbil sales gas split, and minimum Erbil sales gas arrival pressure. This means that the residue gas from:

- KM250A sales gas needs to be compressed from 37 to 104 barg
- existing Cryo# and EPF plants needs to be boosted in pressure from 65 to 104 barg.

During this phase of the gas plant expansion the KM250A gas and Cryo#/EPF gas will be compressed using, respectively, sales gas and booster rental compressors to minimise CAPEX and project schedule. Separate sets of rental compressors will be used for the existing Cryo#/EPF plant and the new KM250A plant although all the compressors will be located next to each other in the same plant area (adjacent to the existing Cryo# plant for ease of access to the existing gas export pipeline). Reciprocating compressors driven by gas engines will be used. The rental compressors are spared to provide sufficient equipment availability and each compressor has sufficient isolation to allow a single compressor to be taken offline for maintenance without affecting plant throughput.

2.5.6.8 Condensate feed separator and inlet filter

Condensate collected in the plant reception facilities (in the inlet liquid/liquid separator) will be routed under level control to the condensate stabiliser feed separator. The condensate stabiliser feed separator is a conventional 3-phase separator that removes gas flashed from the condensate as it is reduced in pressure from the gas train operating pressure and removes any water that has been carried over from the upstream separation system, before the condensate is routed to the condensate stabiliser. Gas from the vessel is routed to the stabiliser overhead compressor. Condensate is routed to the condensate stabiliser (via coalescing filtration and heat exchange) under level control. Water is routed to the produced water degasser.

2.5.6.9 Condensate stabiliser

The condensate stabiliser ensures that the Reid vapour pressure and H_2S content of the condensate routed to export is within specification. Vapour from the condensate stabiliser is routed to the stabiliser overhead compressor. A relatively high required operating pressure for the condensate stabiliser calls for a relatively high temperature in the condensate stabiliser reboiler for the condensate to meet specification. The reboiler is a partial kettle type reboiler with an overflow weir.

The column is equipped with a mist matt on the outlet to minimise liquid carryover to the downstream Compressor Suction Scrubber. The stabiliser is a trayed column. Water trapped within the stabiliser will be removed by manually draining liquid from the column.

Liquids from the condensate stabiliser are routed via the feed/treated condensate heat exchanger to recover heat by the feed stream to the stabiliser before being routed to the condensate product cooler. Condensate from the condensate stabiliser and the condensate from the debutaniser bottoms are cooled by an air cooler, combined and then routed to storage.

2.5.6.10 Condensate and liquified petroleum gas storage and export

New condensate storage will be provided as part of KM250A project. The storage will be sized for seven days of production as part of KM250A project and will be located in the Development Area. LPG will be stored in the existing facility for the KM250A project and no new LPG storage is anticipated as part of the present project.

Condensate will be exported from the site by either pipeline or truck. If by pipeline, condensate will be exported via the existing 20” condensate pipeline to Jambur. The pipeline route crosses the proposed KM Expansion Area. The rerouted pipeline size will be 20” to accommodate export from the EPF/Cryo# and KM500 plants.

KM250A will include a truck loading station for condensate produced. The condensate loading capacity for KM250A will be 13,000 bpd. Considering a condensate truck loading rate of one truck per hour per loading bay, seven loading bays, of which six will be operational and one spare at any time, will be designed as part of KM250A project.

The condensate truck loading station will have the following:

- truck bottom loading
- truck vapor recovery system
- spillage control including
- emergency shutdown valves
- drainage and interception arrangements
- capacity control and over-fill protection system.

There will be truck weighbridges (four in total – two for incoming trucks and two for outgoing trucks). Appropriate fencing will separate the truck loading bays from the process plant areas and offsite areas.

2.5.7 Utilities for the KM250A Project

The main utilities dedicated to the KM250A Project are the:

- HP/LT flare
- LP flare
- LLP flare (for condensate tank vent gas)
- thermal oxidiser
- tanker loading (air diluted) cold vent
- compression cold vent
- drainage system (closed, open and local drains).

The following will be shared with future KM expansion projects:

- produced water treatment
- domestic water
- plant water
- utility water
- hot oil circulation and heater

- power generation
- fuel gas
- plant and instrument air
- nitrogen generation
- demineralised water
- firewater system.

Further details on key utilities are provided in the following sections.

2.5.8 Flares

The design includes the following flare systems:

- HP flare system, with two separate headers
- HP flare header (for hot/wet releases)
- low temperature (LT) flare header (for cold/dry releases)
- LP flare system, with a single header
- low-low pressure (LLP) flare system for condensate storage where a very low backpressure is required.

Each of the flare systems will be provided with its own dedicated KO drum, associated pumps and flare stack with pilot and ignition systems. Liquids collected in the HP flare KO drum are pumped to the LP flare KO drum from where combined liquids are pumped to the condensate stabiliser feed separator for reprocessing. The LP flare KO drum will also receive liquids for reprocessing from the closed drain drum.

Common HP and LP flare systems shall be provided for KM500 (that is, suitable for both KM250A and KM250B combined). These shall be provided initially in a temporary location, close to the KM500 plot space south of the KM250A gas plant site, within the existing site fenceline, and will be moved at a later stage to a remote flare system area outside of the southern site fenceline. All flare hydraulics shall be based on the final flare location and the HP and LP flare headers provided with flanged tie-ins, without valves, to allow future tie-in of the permanent flare systems. It is intended that the temporary flare systems initially provided for KM500 will be used for later gas plants (that is, KM1000).

There will be no routine flaring during operations.

2.5.9 Thermal oxidiser

The H_2S-rich acid (sour) gas from the amine still is routed to the thermal oxidiser, joining the off-gas stream from the amine flash drum. The thermal oxidiser combusts the acid gas using fuel gas, resulting in the release of sulphur dioxide (SO_2) to the atmosphere. There is provision in the design to install a future sulphur recovery unit (or other solution) upstream of the thermal oxidiser so that sulphur emissions to the atmosphere can be reduced. The thermal oxidiser will be located in the liquids fractionation area.

2.5.10 Drainage

The drainage system is designed to allow the disposal of liquid inventory and surface water runoff from the Project site in a safe manner. The Project will have closed and open drains. Aqueous and hydrocarbon fluids will be segregated in both systems.

2.5.10.1 *Closed drain*

Closed drains will be provided to collect the hydrocarbon residual liquids from process equipment. The closed drain system will be a hard-piped collection system based on gravity flow for the collection of drain liquids. The closed drain system will have vent lines connected to the LP flare system.

No process system will be drained to the closed drain system unless the process system is fully depressurised. Hydrocarbon liquids collected in the closed drain drum will be pumped to the condensate separator, which is an automatically initiated operation. An alternative disposal route to the new condensate storage tank will also be provided for use during the full plant shutdown. Aqueous fluids collected from the closed drain drum will be pumped to the produced water treatment facility.

2.5.10.2 *Open drain*

Equipment drains (predominantly water) will be collected in the open drain. Open drains will be provided in each area to handle water that has been accidently contaminated with oil. It will also receive runoff water from paved areas within the plant utilities, which may contain traces of oil, grease and chemicals. The sources of water include precipitation, vessel wash water and firewater. The open drain system will be a hard-piped collection system, with drain liquids flowing by gravity to the collection sump.

The collection system will be provided with traps to prevent possible hydrocarbon vapours from being released within the plant area. The sump will be open to atmosphere and provided with an oil skimmer. The collected liquid will be sent to an oily water treatment package; the treated water will be discharged via the stormwater interceptor. The skimmed oil will be pumped to a slop oil tank and disposed with other hydrocarbon waste to an offsite waste oil processing facility.

2.5.10.3 *Local drains*

Local equipment drains will be provided to allow drainage into a temporary container via flexible hose connections or to the closest open drain system via drip tray.

2.5.11 Venting

An air assisted vent will be provided to dispose of gases vented from condensate trucks during filling operations. Vapours released from the tankers during filling will be diluted with air using forced draught and the vapours released to atmosphere via a vent (approximately 1300 tonnes/year). Pearl Petroleum is considering various abatement measures, including flaring and a vapour recovery unit. These options will be further investigated during the detailed engineering phase of the Project. A new condensate export pipeline to Chemchemal will be installed in the near future which would obviate the need for tanker loading operations at KM.

A cold vent is provided for the rental sales gas compressors. The cold vent will be used for emergency blowdown of the compressors and for maintenance depressurisation. Volumes vented are expected to be low and infrequent.

Atmospheric vents will be provided for the release of air and inert gases if required. Atmospheric vents will be blinded during routine operation to prevent accidental releases.

2.5.12 Produced water

Production wells are initially expected to produce very little water (based on experience of existing wells), such that only condensation water will be produced. Later in field life produced water is expected to break through into the wells such that the design flow of water is to be 11,000 bpd. The timing of increased produced water production is difficult to predict. Consequently, the produced water treatment system is designed such that its capacity can be easily expanded when required.

Produced water will be sent to the produced water degasser. The KM250A produced water treatment plant shall initially be designed with a capacity of 2,000 bpd, with the capability to be expanded up to 11,000 bpd. Produced water shall be treated to a standard where it can be safely discharged to the environment. Water from the degasser is routed to a skimming tank via a coalescer to remove any hydrocarbons; water from the skimming tank is routed to a lined evaporation pond for disposal. Water in the evaporation pond will contain less than 100 mg/L of condensate (Hatch, 2019c). Gas from the produced water degasser will be routed to the LP fuel gas system.

2.5.13 Hot oil circulation and heater

The hot oil circulation will provide heat to various process units (via heat exchangers) using hot oil as the heating medium. The system includes the hot oil heater, the hot oil expansion vessel, hot oil circulation pumps and hot oil filter. The hot oil circulation system will have a design temperature of 305°C. The hot oil heater will be fuelled by fuel gas.

2.5.14 Power supply

The KM500 expansion project, including the KM250A Project, will be developed on a new site with no existing power supply available. There will be no connection to the existing Cryo# plant electrical supply system, although there will be flexibility to do this in the future. The permanent electric power supply for KM500 project shall be supplied from a central power plant based on gas turbine generators that is planned in the next project phase of KM expansion (KM1000). Initially, temporary rental gas engine generator sets shall be used to supply KM500 (including KM250A) project loads to minimise initial capital cost. Central power generation, temporary and permanent, will be located in the utility area near the electrical main substation. Power generation will be at 11kV.

A 400V emergency diesel generator shall be installed to serve critical electricity loads during shutdowns at the electrical main substation.

2.5.15 Safety exclusion/buffer zones

Neither KRI legal requirements nor MNR policies or environmental guidelines prescribe safety zones in relation to industrial facilities. The International Finance Corporation Environmental, Health and Social General Guidelines call for '[r]educing offsite impacts of releases through measures intended to contain explosions and fires, alert the public, provide for evacuation of surrounding areas, establish safety zones around a site, and ensure the provision of emergency medical services to the public.' Project KM250A-related hazard analyses provide estimated safety zones for a variety of unplanned events, including jet flames, flammable gas dispersion, pool fires, toxic gas dispersion and explosion overpressure (see Fire & Dispersion Hazard Analysis, Hatch, 2018 and Section 5.10 Impact assessment for unplanned activities). The size of the KM site and the distance to the nearest sensitive receptors outside of the site fenceline imply that safety zones extending outside of the fenceline may not be necessary; this will be further evaluated by Pearl Petroleum during the detailed design phase (see Section 5.10). Nonetheless Pearl Petroleum will continue to work with Project-affected communities with regard to emergency response planning and exercises; the existing Emergency Response Plan will be extended to incorporate the KM250A Project (see Section 11 Safeguards, Measures and Plans).

Buffer zones could eventually be designated in relation to recognised biodiversity or critical habitat zones within the KM250A Project biodiversity/ecology area of influence following further evaluation (see Section 6 Mitigations measures). The engineering, procurement and construction (EPC) Contractor will establish a temporary exclusion zone around the flowline construction sites. Once the flowlines are covered and the area revegetated, the flowline RoWs will be reopened to local stakeholders, although certain activities within the exclusion zone for the life of the KM250A Project (especially digging and installation of structures).

2.6 Project activities for all Project phases

2.6.1 Construction phase

The expected duration of the construction phase of the KM250A Project is from end Q2 2020 to Q1 2022, and first gas is due in Q1 2022. Activities to be carried out during the various construction activities are described in the following sections. Construction activities are not planned to be conducted over 24 hours each day, but certain activities may be implemented past the normal working day.

2.6.1.1 Early works

Construction at the Project site will commence with site preparation works by the early works contractor. The site will be cleared of vegetation as necessary. The areas designated for the gas plant and associated infrastructure will be levelled with the associated surface drainage structures to manage surface run-off. Construction of retention ponds will ensure that the impact on the receiving environment is minimised. In addition, a diversion channel will be constructed to minimise water management within the new KM Development.

Where the foundations of the process train are to be constructed, natural soil will be excavated for the installation of shallow or spread foundations. All materials used for backfilling over foundations shall be compacted as per civil specifications requirements. Piles may need to be driven for some structures to ensure stability.

Cut and fill bulk earthworks will be required with estimated excavation and backfill volumes presented in Table 2-3.

Table 2-3 Cut and fill earthworks

Site area	Volume (cubic metres)		
	Stripping	Cutting	Filling
KM development	238,500	694,000	630,000
North development	18,000	55,000	149,000
Camp/offices	29,000	73,000	67,000
New warehouse	12,000	73,000	68,000
Total	297,500	895,000	914,000

Aggregate required for backfilling will be transported from a quarry by truck. The volume of aggregate and other materials required will be specified during the EPC phase of the Project. Further earthworks will be required after early works, with required volumes of backfilling to be determined during that stage of the Project.

The surface will be sealed concrete paving in equipment areas where hydrocarbon spillage could occur. Specific activities will include grading and drainage of:

- KM250A Project site
- Development Area.

A road layout will be designed. For road structures, sub-base and base layers shall be put in place before paving and other areas with no traffic might require paving to favour surface drainage. Gravel surface will be placed at places where there is no paving or roads.

The early works contractor will excavate culverts and ditches.

Water will be sprayed to suppress dust while earthworks are undertaken.

The following other activities are due to take place as part of the early construction work:

- demolition or removal of warehouses/equipment laydown area and the drilling equipment warehouse located in the North Development
- relocation of Cryo# LPG offices and car parking
- cutting of 20" Jambur pipeline and removal of the parts of the pipeline that are within the Khor Mor site and rerouting
- protection of existing Flowlines and other services within the limits of the Project.

The elevation of the Project equipment pads will be developed to achieve a cut and fill balance, so no materials will need to be sourced from outside the site to be used as general backfill. Granular material will nonetheless be required and will need to be sourced outside the plant from existing nearby quarries.

Early works will be managed under a specific Project HSE Plan for each scope. Bridging will be in place between the relevant contractor and Pearl Petroleum. The specific Project HSE procedures (for example for control of work) have already been established. The e bridge will determine whether the contractor, an existing Pearl Petroleum operation, or a Project-specific procedure will apply

2.6.1.2 *Installation of main equipment*

2.6.1.2.1 Gas plant

The process equipment, pipe racks and piping will be modularized as far as possible, with a view to minimising site construction work based on compliance with the transport envelope and adherence to the design, operability and maintainability of equipment. Modules of process equipment will have been hydrostatically tested (hydrotested) before leaving the supplier. New welds will be hydrotested at the site. After Pearl Petroleum verifies that they conform to the facility design, they will be moved into their final position using trucks and cranes. Utilities and pipelines will be connected.

2.6.1.2.2 Flowlines

The flowlines from production wells to the gas plant will have the same stages of construction. Where a new flowline is to be installed alongside an existing hydrocarbon pipeline, appropriate separation distances will be observed to prevent accidental damage to the existing pipeline.

The buried flowline installation stages are as follows:

- RoW preparation, stripping and grading
- pipe stringing
- welding
- excavating the trench
- lowering flowline segments into the trench
- backfilling the trench.

The flowline RoW will be surveyed and marked out. As necessary, stakeholder engagement will determine whether (and where) the working corridor may disturb farmland, and where land is sufficiently fertile to warrant clearing of vegetation, stripping of topsoil and stockpiling vegetation and topsoil for re-use during reinstatement work. The flowline contractor will grade the RoW to create a suitable work surface for construction vehicles and erect temporary security barriers around the section of the RoW where work is in progress.

Flat-bed trailers will transport the pipe sections to the laydown areas where they will be stockpiled. When the RoW has been marked out, trucks will set down sections of pipe along the route, laying the ends on sandbags or pipe holders to protect the pipeline coating. A mechanical excavator will dig a trench of suitable width and depth for the diameter of the pipeline in question along the marked pipeline route.

Soil from excavating the trench will be placed into heaps running beside the trench. The trench will be deep enough to allow the pipeline to be buried with 1.2 m of fill over the top of the pipe. If the trench bottom has abrasive soils that could damage the pipeline's polyethylene coating, clean sand from local commercial sources will used as padding to line the bottom of the trench and give the pipeline a smooth bed to lie on.

The pipeline contractor will line up the pipeline sections, fixing the ends with clamps, and weld the sections together to form a continuous pipeline. Once the welds have been inspected radiographically or by ultrasound and the welds approved, polyethylene shrink wrap coatings will be applied to protect the field joints. Side-boom tractors will lift the pipeline and lower it into the trench. When it has been installed in a section of trench, the pipeline coating, field joints, fittings, and bends will be inspected and repaired as necessary, before backfilling.

Mechanical excavators will use rock-free sand to backfill around the pipe and to cover the pipe to a depth of 30 cm from the surface. The contractor will then backfill the rest of the trench using native material excavated during trenching. The backfilled earth will be compacted using a roller or hydraulic tamper.

2.6.1.3 *Construction equipment*

The use of construction equipment and expected duration is shown in Table 2-4.

Table 2-4 Indicative list of construction phase equipment

Equipment type	Total months of use of all pieces within each category
300 ton crane	8
120 ton crane	16
60 ton crane	62
30 ton crane hi-up	318
Flatbed truck	84
Trailer truck	18
Manlift	322
Telescopic handlers	58
Forklift	22
Concrete batching plant	8
Excavator	30
Shovel	26
Grader	19
Compactor	17
Truck	38
Water tank	28

2.6.1.4 *Construction camps and workforce*

There will be a requirement of 500 to 1000 workers during the construction phase. As process equipment is commissioned, the size of the construction workforce is expected to decrease rapidly. A large number of these workers will reside in the construction accommodation camp within the current KM site fenceline. Other workers will come from the Chemchemal and Kirkuk areas or locally and will commute to the site by buses to be provided by Pearl Petroleum. Pearl Petroleum expects the construction contractor's workforce to start at low numbers when the site is being cleared and the construction camp being prepared. The work force will then ramp up as main construction activities (especially installation of equipment) begin. All construction workers will be part of the contractor or sub-contractor workforce.

The majority of construction workers will reside at the site. The construction camp will be self-contained and include contractor accommodation, catering/welfare facilities, workshops, warehouses and equipment/piping/materials laydown areas, as well as security, office buildings, accommodation units, catering and laundry services, mosque, medical clinic and recreational facilities. Camp utilities typically include diesel power generators, diesel fuel storage, potable water storage, sewage and wastewater treatment, irrigation water storage and treated wastewater evaporation pond (lined). Car parking areas for cars and buses stop will facilitate worker transportation.

An area in the south of the KM Expansion Area has been selected for the KM250A Project construction camp.

2.6.1.5 Requirements for chemicals and other raw materials

In addition to standard construction materials, to be specified during the EPC phase of the Project, the following materials are of note because of possible implications in terms of environmental impacts (for example in the case of spills):

- lubricating and hydraulic oils for moving and stationary equipment
- diesel oil for moving and stationary equipment (including gensets).

Further details in terms of required quantities will be developed during the EPC phase of the Project.

2.6.1.6 Transport and access routes

Transport of people and other equipment will be required during the construction phase of the Project. Logistics will be assessed and specified during the EPC phase of the Project. Access routes for bringing the construction workforce to the site and for importing equipment and raw materials have been defined (see Figure 2-6). Local construction workers are expected to use the local roads to commute to site.

It is anticipated that much of the construction material (including equipment modules) will be delivered to Mercin Port in Turkey. Equipment will be transported by road to the laydown areas at the KM site via the Habur Border Gate/Zakho Border and either Chemchemal and/or Kirkuk. The size specification for transporting modules depends on the size and weight constraints along the transportation route. Some civil materials such as rocks and gravel will be sourced from local quarries.

The construction camp will be confined to the east of the central road and all construction traffic will enter/leave the site by the South VCP (for KM Expansion Area) or by the new East VCP (for Development Area). The South VCP gatehouse will prevent construction traffic travelling up the central road.

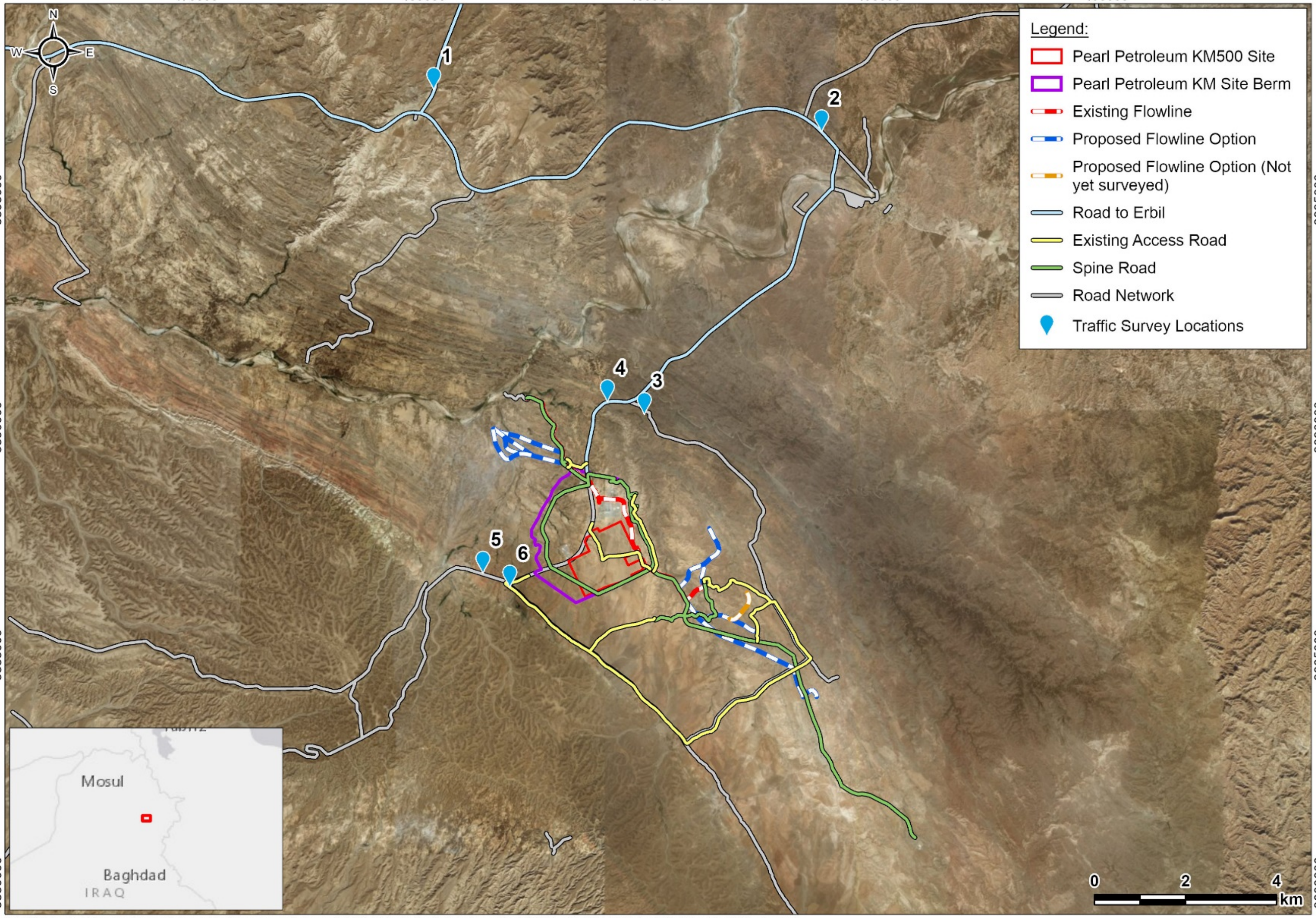


Figure 2-6 Planned access routes during construction phase of KM250A Project

2.6.1.7 *Site security*

The KRG Ministry of Interior provides and manages an Oil Police Force (OPF) of 125 persons to protect and secure the immediate local area of the KM oil and gas production fields and gas processing facility. This service includes permanent road checkpoints on roads outside of the KM processing facility fenceline as well as protection of the 11 km processing facility perimeter. Pearl is invoiced by MNR for services provided by the OPF at an agreed rate that applies to all oil and gas operators in the KRI.

A further 52 Peshmerga personnel are deployed by the KRG for area security; additional forces are provided by the Counter Terrorist Unit based within the KM area as required. The Asaish (local police force) also support protection of the site.

Security within the KM site is the responsibility of a private security company that was contracted by Pearl Petroleum for two years via an open tender process that conformed to MNR procurement guidelines. This group provides mobile armed escort services, static guarding services, explosive detection and canine search teams. The contract is re-tendered bi-annually to ensure that the services provided are in line with the latest KRG security threat matrix and the current security situation at the KM site. Pearl Petroleum policy and standard procedures are integral to this contract.

The MNR have a full-time representative at the site; this person participates at many of the regular business meetings held at the site, and has the right to participate at all meetings. Pearl Petroleum actively engages and consults with the MNR representative on all matters. Pearl Petroleum’s regional General Manager, based in Erbil, has weekly meetings scheduled with the senior MNR representative to address all aspects of the business. Topic-specific engagement occurs on a frequent basis.

The current permanent asset protection/security presence on-site will be maintained throughout the construction phase of the Project. Access to the site will be via the South and East VCP where vehicles will be security screened. Within the site, a new asset protection control building will be constructed to provide overall services, and as access to the process plant. This system will be in place for all Project phases (that is, construction, pre-commissioning/commissioning, operations and decommissioning) and is therefore not covered in those sections.

Pearl Petroleum supports voluntary principles regarding security and human rights in the extractive sector, concerning risk assessment, relations with public security, and relations with private security:[1]: Key features of these principles, which are in place at the existing KM site, are as follows:

- The ability to accurately assess risks present in the operating environment is critical to the security of personnel, local communities and assets, the success of Pearl Petroleum's short and long- term operations; and to the promotion and protection of human rights. Civil society, home and host government representatives, and other sources are consulted to identify risks presented by the potential for violence. Pearl Petroleum will examine any patterns of violence in areas of their operations. Available human rights records of public security forces, paramilitaries, local and national law enforcement, as well as the reputation of private security, are considered. Identification of and

[1] Adapted by Pearl Petroleum based on Khor Mor LPG Recovery Plant CPDG Corporate Security Policy (document KM-P-SEC-001 Rev. 4).

understanding the root causes and nature of local conflicts, as well as the level of adherence to human rights and international humanitarian law standards by key factors is instructive for the development of strategies for managing relations between Pearl Petroleum, local communities, Pearl Petroleum employees and their unions, and host governments.

- Pearl Petroleum recognises that Iraqi and Kurdish regional governments have the primary role of maintaining law and order, security and respect for human rights. Pearl Petroleum have an interest in ensuring that actions taken by those governments, particularly the actions of public security providers, are consistent with the protection and promotion of human rights. Pearl Petroleum consults regularly with host governments and local communities about the impact of their security arrangements on those communities and communicates their policies regarding ethical conduct and human rights to public security providers.
- Pearl Petroleum records and reports any credible allegations of human rights abuses by public security in their areas of operation to appropriate host government authorities. Where appropriate, investigations are undertaken and actions are taken, as required, to prevent any recurrence.
- Private security entities employed by Pearl Petroleum must observe Pearl Petroleum policies regarding ethical conduct and human rights; the law and professional standards of the country in which they operate; emerging best practices developed by industry, civil society, and governments; and observance of international humanitarian law. Private security must maintain high levels of technical and professional proficiency, particularly with regard to the local use of force and firearms. Private security must exercise restraint and caution in a manner consistent with applicable international guidelines regarding the local use of force, including the United Nations Principles on the Use of Force and Firearms by Law Enforcement Officials and the United Nations Code of Conduct for Law Enforcement Officials, as well as with emerging best practices developed by Pearl Petroleum, civil society, and governments.

No formal memorandum of understanding is in place concerning provision of the above services; however, Pearl Petroleum has outlined its expectations regarding the voluntary principles and use of force with the MNR and OPF representatives, who have verbally confirmed that the principles have been established for government forces. Pearl Petroleum maintains regular and frequent contact with public security forces, ranging from field level contacts (between Pearl Petroleum's Asset Protection Manager and local security forces) to senior level contacts (between Pearl Petroleum's senior leadership and KRG/MNR/Ministry of Interior representatives).

2.6.2 Pre-commissioning and commissioning

2.6.2.1 Gas plant

The overall goal of pre-commissioning is to ensure that all equipment functions safely and performs as expected. The EPC Contractor will test individual process units before delivery to the site. Flanged pipe spools will be hydrotested remotely before installation. Fully welded pipework will be hydrotested in situ and dried or pressure tested with inert gas.

Utility systems will be tested, including water supply and treatment, heating and cooling systems, instrument air systems and emergency shutdown systems and firefighting systems. The instrumentation and the power systems will be tested.

During commissioning, process train modules will be tested individually, flaring gas until the export product specifications are met. The use of water and chemicals will be minimised by reusing hydrotest water where possible.

Pipelines are typically tested in sections isolated by block valves in order to minimize the water required for the test. The water will be stored for re-use when testing subsequent pipeline sections. During the hydrotest, water in the pipeline will be held at a pressure above the pipeline's operating pressure for the test period. Any pressure losses indicative of leaks will be investigated.

When hydrotesting is complete, the spent hydrotest water will be tested to determine if it meets Iraqi standards for irrigation water, treated to ensure that it complies with Iraqi and KRG water quality requirements for disposal to land, and if so, it will be discharged to the ground directly. If the water cannot be treated to meet the standards, it will not be discharged the environment. Instead it will be discharged to a lined evaporation pond or similar.

After the hydrotest, pigs will be run to remove the water from the pipeline. Any water remaining in valve body cavities and dead ends of piping will be drained. Flowlines will be dewatered before use by forcing dry air or nitrogen through the pipeline, or by pumping methanol or glycol ahead of the first gas or liquids.

Control equipment, communications system, pressure and flow monitoring systems and safety systems (including emergency shutdown) for each flowline will be tested to verify that they have been properly installed and are functioning correctly before Pearl Petroleum accepts the flowlines as mechanically complete and operational. The flowlines will be purged and filled with gas.

The flowlines will be commissioned at the same time as the process units of the Pearl Petroleum gas plant. The pipeline will then be handed over to the Pearl Petroleum operations team.

2.6.2.2 Requirements for chemicals and other raw materials

Hydrotest water is usually treated with biocide and oxygen scavenger to inhibit corrosion and its pH is adjusted with caustic soda and buffered with bicarbonate. Methanol may need to be injected into the flowlines during commissioning to inhibit hydrate formation.

2.6.3 Operations phase

The plant will be operational for the initial KM250A phase and the products (mainly sales gas, LPG and condensate) will be exported to the end-users via export pipelines or through trucks. KM250A Project operations will require additional workforce for their routine operations (see Section 2.6.3.4 below). There will be a regular requirement for raw materials, chemicals and additives for routine operations.

Pearl Petroleum will have its own dedicated management and operations teams with responsibility for managing the Project process facilities, utilities, power supply and emergency systems. Control room personnel will control and monitor production parameters 24 hours a day, 365 days a year. The control centre will also electronically monitor the operation of the pipelines.

Pearl Petroleum will operate plant lighting at night for safety. The plant is designed not to require flaring during routine operations, but flare systems will be available for use when required and flare pilots will remain lit at all times.

During operations there will be significant logistics activity. Supplies of, proprietary oil for the hot oil system, amine, and water treatment chemicals will be procured and delivered to the Project site by road.

2.6.3.1 Requirements for chemicals and other raw materials

The following materials are of note because of possible implications in terms of environmental impacts (for example in the case of spills):

- methanol for LPG recovery section hydrate inhibition (to be injected as required) and flowline start-up/shutdown.
- lubricating and hydraulic oils for moving and stationary equipment
- diesel oil for stationary equipment (especially during unplanned situations)
- molecular sieve/silica gel (for the dehydration unit)
- electrical transformer oil
- chemicals for produced water treatment package
- chemicals for raw water treatment systems (possibly including biocide and oxygen scavenger)
- corrosion inhibitor to be injected into flowlines on a continuous basis once formation water is entrained with gas from production wells (Hatch, 2019)
- corrosion inhibitor for the amine unit (desulphurisation)
- DEA for the amine unit
- anti-foaming agent for the amine unit
- de-emulsifier for raw gas inlet separation
- mercury absorbent for mercury guard bed (typically replaced every 5 to 10 years).

Further details in terms of required quantities will be developed during the EPC phase of the Project. All chemicals and wastes are managed in accordance with GIIP.

2.6.3.2 Emergency situations

Correct design of the relief, flare and blowdown systems ensures that process fluids required to be removed from pressure equipment to maintain equipment containment can be safely disposed of. The blowdown system ensures that pressure equipment can be depressurised quickly and safely if there is a threat to containment from external fire or minimise the release size in the event of a loss of containment. These systems reduce the potential for loss of containment due to overpressure and hence ensure personnel and equipment are protected. The flare system provides safe and effective disposal of all flammable hydrocarbon inventory from process equipment.

The relief sources are therefore routed to either the HP or LT flare header according to the following principles:

- Any relief/blowdown source which has a temperature less than -44°C after let-down is routed to the LT flare header.
- Any relief/blowdown source that is warmer than -44°C after let-down but does not have appreciative amounts of water may be routed into the LT flare header

if routing to the HP flare header would be more costly (e.g. if a separate HP sub header would need to the area for that source). Otherwise it can be routed to the HP flare header.

- Any relief source that has appreciative amounts of water must be routed to the HP flare header.
- LP vent sources are routed to the LP flare header.
- Vents/blowdown of temporary sales gas/booster compression is routed to a local cold vent.
- Vent gas from the new condensate storage tank is routed to a dedicated LLP flare.

2.6.3.3 Maintenance

Pearl Petroleum has a permanent maintenance team with its own maintenance storage and warehouse which will be based at the KM site. The maintenance team performs routine maintenance of rotating equipment and pumps, such as topping up lube oils and fitting replacement parts. Firefighting systems will be function tested regularly.

Planned major maintenance will be conducted in accordance with the plant maintenance strategy and plan, based on criticality analysis, reliability and availability requirements. This will allow for the internal inspection of vessels and contactor beds, and the replacement of spent catalysts and mol sieve. It will also allow safety critical equipment to be tested.

Pearl Petroleum staff will drive the pipeline routes on a regular basis to inspect the pipelines for problems that may lead to damage and to look for any sign of leaks. Planned maintenance of the pipelines will include running pigs for condition monitoring and corrosion management.

2.6.3.4 Permanent workforce

Approximately 80-100 additional operational staff will be required for the KM250A operations. A philosophy of minimum permanent manning will be adopted for the project based on simple, robust, proven and reliable production system design, and multi-skilled technicians.

2.6.3.4.1 Accommodation

Operations staff will be based in the site accommodation block and have a rotational cycle with equal time off. Therefore, two postholders (‘back-to-back’) will occupy each position. Production staff will provide 24-hour cover working 12-hour shifts. Maintenance staff will work day shifts but will provide night and emergency cover.

2.6.3.4.2 Recruitment

Local labour will be employed by Pearl Petroleum at the KM site to the maximum extent possible, with due consideration to the technical job description and availability of local workers who meet the requirements laid out therein. The workforce will travel to the KM250A Project site from the local area or stay at the construction accommodation camp.

2.6.3.4.3 Training

Pearl Petroleum provides in-house training for all positions related to the existing (LPG plant) site. This will be extended to the KM250A Project. Induction training for new employees is offered in security and health, safety and environment (HSE). Regular training will be provided to workers according to their respective positions, include

- emergency response
- workplace safety (e.g. working in confined spaces and at height)
- first aid
- personal protective equipment (PPE).

Third party training is also offered.

2.6.3.5 *Local procurement*

Contracting and procurement procedures will be fair and equitable. Pearl Petroleum will give preferential treatment to the procurement of goods and services originating from Kurdistan, when such goods and services are internationally competitive with respect to quality, availability, price and performance.

2.6.4 Decommissioning

The plant will be decommissioned once Pearl Petroleum determines that its effective life has been achieved. Specification of decommissioning activities will be developed closer to the decommissioning date. Decommissioning activities will be executed in a manner consistent with the Decommissioning Plan which will be agreed with the MNR prior to commencing decommissioning activities. For safety of personnel and the environment, decommissioning activities will be implemented after operations have been ceased and equipment properly deactivated.

Pearl Petroleum is likely to return the site to its pre-development condition following decommissioning, although the decision regarding the state of the site to be achieved following closure will be based in part on further assessment by Pearl Petroleum and consultation with responsible authorities and other stakeholders, which will take place closer to the expected date of plant closure. Typically, decommissioning a facility involves the following stages:

- depressurise plant
- remove all hydrocarbons to render the plant inert
- remove all chemicals and certify that the whole plant is hydrocarbon and hazardous chemical-free
- disconnect and dismantle the equipment, and remove modules and scrap from the site for refurbishment or recycling
- demolish structures and paving and remove the materials from site as inert waste
- level the site and undertake soil and groundwater survey to determine whether any remediation is needed.
- spread stored topsoil for site rehabilitation.

Typically, decommissioning pipelines by cleaning and abandonment *in-situ* involves little environmental disturbance. If the flowlines are removed, decommissioning would involve the following stages:

- flush and inert the pipelines using water and pig trains, then empty them
- excavate the pipeline trenches

- cut the pipeline into sections, lift them from the trench and remove as scrap for recycling
- backfill the trench and restore the RoW to its original profile, spreading topsoil and replanting where appropriate.

A Decommissioning Plan for the KM site and wells will be developed. The detailed programme for decommissioning will be determined and agreed with the KRG authorities prior to shut down. Decommissioning and dismantling will be performed by specialist contractors supported by a core team of project operations and maintenance personnel and will need to follow the waste hierarchy to minimise waste.

2.7 Resource consumption

2.7.1 Construction phase

Estimated material volumes that will be used is presented in Table 2-5.

Table 2-5 Estimated quantities of construction phase materials

Category	Unit	Quantity
Earthworks, roads, fencing, infrastructure	m^2	920,000
Foundations and structures	m^3	3,573
Buildings	each	16
Steel	ton	4,255
Piping	lump	34,640
Mechanical equipment	ton	4,498 (377 nos.)
Electrical work cable	lump	89,338
Instrumentation & telecoms cable	lump	101,570
Water for dust suppression*	m^3	43,200*

* Based on 30 days for 4 months at 360,000 L/day

m^3 – cubic metres

2.7.2 Operations phase

Resources required will be as follows:

- Anticipated power generation requirement for the KM250A gas processing plant during operations is 8.9 MW (including a 20% growth factor)
- DEA and other chemicals will be consumed at the site (see Section 2.6.3.1)
- Molecular sieve will be required for occasional replacement
- Fuel gas will be taken from on-site gas production.

Hot oil heaters are estimated to consume 2.33 metric tons of fuel gas per hour, and the flare pilots will consume 0.58 metric tons of fuel gas per hour. Annual fuel gas consumption at the Project site is expected to be about 7800 m^3/h (about 5.9 metric tons per hour). Water use has been estimated as per Table 2-6. These quantities will be further defined during detailed design.

Table 2-6 Expected Project water use during operations

End use	Estimated volume	Source
Raw water	45 m^3/h	Direct from well via Offsites Area
Demineralised water	300 L/h	Tank
Domestic water	14 m^3/day	Tank
Utility water	10 m^3/h (intermittent)	Tank
Firewater test*	125,500 L/month	Tank

* Based on 25 hydrants fully opened for flush and visual flow check for approximately 30 seconds each = 12.5 mins @ 5,833 L/minute = 72,913 L Random hydrant flow testing for approximately 3 minutes each = 9 mins @ 5,833 L/minute = 52,497 L

2.7.3 Decommissioning phase

Resource consumption during the decommissioning phase will be similar to that during the construction phase of the Project.

2.8 Emissions, wastes and other environmental issues

2.8.1 Air emissions

2.8.1.1 Construction phase

During the construction phase, Pearl Petroleum and their contractors will utilise vehicles[2], machinery and site equipment powered by internal combustion engines. This can result in the emission of exhaust gases containing air pollutants such as nitrogen oxides (NO_x), particulate matter particles smaller than 10 microns (PM_{10}), volatile organic compounds (VOCs) and carbon monoxide (CO). The quantities of exhaust gas emitted will depend on factors such as engine type, service history, pattern of usage and fuel composition.

Construction traffic will comprise haulage/construction vehicles and vehicles used for workers' trips to and from the site. Fugitive dust emissions arising from construction activities are likely to be variable in nature and will depend upon the type and extent of the activity, soil type and moisture, road surface conditions and weather conditions. For example, periods of dry weather combined with higher than average wind speeds have the potential to generate more dust.

The Project construction activities considered to be the most significant potential sources of fugitive dust emissions are:

- size reduction and handling of materials including rocks
- clearing, trenching, backfilling and other earth moving activities – due to handling, storage and disposal of soil and subsoil materials
- construction aggregate usage - due to the transport, unloading, storage and use of dry and dusty materials (such as cement and sand)
- movement of heavy site vehicles on dry or untreated haul routes

[2] Construction traffic will comprise haulage/construction vehicles and vehicles used for workers' trips to and from the site.

- movement of vehicles over surfaces where muddy materials have been transferred offsite (for example, on to public roads).

2.8.1.2 Operations phase

Operation of the process equipment at the Pearl Petroleum gas plant site will involve routine emissions of combusted gas from hot oil heaters, flare pilots, gas engine driven compressors and generators, thermal oxidiser and incinerator. Fuel gas combustion and hydrocarbon components of waste gases will emit greenhouse gases and the atmospheric pollutants CO, NO_x and SO_2. In addition to fuel gas combustion, the thermal oxidiser will emit SO_2, NO_x and PM_{10}.

The main point sources of air emissions at the KM250A Project site during routine operations will be the following:

- gas driven booster and sales gas compressor
- acid gas thermal oxidiser
- gas driven power generation
- hot oil heater
- flare pilot emissions
- fuel gas purge for the HP and LP flares
- emissions from the LLP flare
- cold vent for the compressor area.
- tanker loading venting.

Emissions will be generated by the waste incinerator, which will run on an intermittent basis (waste will be incinerated batchwise). The supplier of the incinerator and auxiliary equipment will specify controls that will allow emissions to meet Project Standards. While the facility is in operation, small quantities of non-combusted hydrocarbons may escape as fugitive emissions from pipe flanges, valves compressors and pumps. Vehicles operating at the site during operations and delivering supplies to the site or carrying out inspections along the pipeline routes will run on diesel fuel and will emit exhaust gases.

There should not be any flaring during routine operations, except for the LLP flare (concerning condensate storage tank vent gas) and pilot flaring. As mentioned earlier, some flaring may take place prior to maintenance of certain plant equipment. The tanker loading station vent will vent VOCs almost continuously (approximately 1300 tonnes/year) directly to the atmosphere (with an air purge).

In certain unplanned scenarios requiring blowdown of the plant, gas will be routed to the HP/LT and/or LP flares leading to combustion emissions for a temporary period. The emergency diesel power generation unit is also likely to be operated.

2.8.2 Noise

2.8.2.1 Construction phase

Site preparation will involve the use of:

- construction plant including excavators, bulldozers, asphalt pavers and rollers that typically generate less than 75 decibels (dB) A-weighted (perceived by human ear) equivalent continuous sound pressure level (L_{Aeq}) at 10 m

- graders, concrete mixer trucks and dump trucks that typically generate 75-80 dB L_{Aeq} at 10 m
- large power generators that typically generate 80-85 dB L_{Aeq} at 10 m.

Installation and erection of process modules will involve the use of cranes and welding set generators that typically generate less than 75dB L_{Aeq} at 10 m.

Pipeline construction will involve the use of:

- excavators, side booms and welding sets that typically generate less than 75 dB L_{Aeq} at 10 m
- dump trucks that typically generate 75-80 dB L_{Aeq} at 10 m
- a rock breaker that typically generate 80-85 dB L_{Aeq} at 10 m.

All these noise sources will be mobile within the limits of the Project site and the flowline RoWs. Furthermore, delivery of process modules by road will involve the use of haulage trucks that typically generate less than 75 dB L_{Aeq} at 10 m.

2.8.2.2 Operations phase

Operating the buried flowlines will not generate noise along the pipeline routes. The electric motors, gas engines and reciprocating compressors at the gas plant site are likely to be the loudest pieces of equipment routinely in use when the plant is operational. Pearl Petroleum's design specification is that engineering solutions will reduce noise levels in the workplace to less than 85 dB(A) at 1 m.

Routine operation of the flare pilots will generate very little noise, but unplanned flares, which are generally used only for short periods, will generate noise. Similarly, air coolers may generate noise. Pearl Petroleum's design specification is that the sound pressure level during flaring shall not exceed 115 dB(A), impulse noise shall not exceed 135 dB and peak noise levels should be kept below 140 dB(A).

2.8.3 Liquids

2.8.3.1 Construction phase

The main expected uses of water during the construction phase would lead to the following sources of wastewater:

- Water used for dust suppression during construction will meet the Iraqi irrigation water quality standard. Daily consumption of 360,000 L has been estimated (Section 2.7.1). This gives approximately 43,200 m^3 of water required over four months of civil engineering works (assuming 30 days of dust suppression per month).
- Water requirement for compaction is estimated at 120,000 m^3, based on optimal water content of approximately 12% or 120 L per m^3 of fill material and approximately 1,000,000 m^3 of fill material.
- An estimated 300 L per person of water will be consumed on a daily basis at the construction worker camp, giving an estimated 300 L sanitary wastewater per person per day (6,000 m^3/month), which will be stored in sewage holding tanks at the construction camp and at the various construction sites and treated at a temporary sanitary treatment plant (STP) at the construction camp. Sewage sludge from the septic tanks will be removed by vacuum truck.

- Waste lubricating and hydraulic oils generated during construction or by maintenance will be contained in a slop tank and sent to an authorised waste oil recycling facility offsite.

2.8.3.2 Pre-commissioning and commissioning phases

The main expected uses of water during the pre-commissioning phase is related to hydrotesting of KM250A flowlines. Assuming a flowline pipe diameter of 10” and a total of 10 km of flowlines, maximum pipeline hydrotesting requirement is estimated at up to 710 m^3 of water, which may need to be treated. Hydrotest water will be reused where possible among the various flowline hydrotest sections to minimise use. When hydrotesting is complete, spent hydrotest water will be treated as necessary to the appropriate irrigation or discharge standard before it is discharged to ground. Water will also be required for testing of the firewater system.

Commissioning phase wastewater generation will be similar to that during the operations phase, although for a much shorter period.

2.8.3.3 Operations phase

The main expected uses of water during the operations phase would lead to the following sources of wastewater:

- process wastewater from the plant, which will be discharged to a lined evaporation pond (the initial flow volume to be disposed of is less than 2000 bpd increasing up to a maximum of 11,000 bpd in late field life)
- 300 L sanitary wastewater per person per day from the site will be sent to the STP.

Plant water will be used periodically for wash down of equipment and process areas.

The firewater system will be tested periodically.

Clean rainwater will run off and soak away. Water from non-routine events, including fire water from the response to fires will be contained in the evaporation basins if contaminated.

2.8.4 Waste

There are landfill sites in the KRI approved by the KRG that receive unsorted non-hazardous municipal waste (food waste, plastic, cans, bottles, aluminium, scrap metal). Current practice in Iraq is to send these types of waste to landfill sites until recycling options become available.

The destination of various waste streams generated at the existing Pearl Petroleum facility is presented in Table 2-7 and will be adapted for all phases of the Project. A facility for managing hazardous wastes to international standards does not currently exist in Kurdistan. Waste oil is considered a hazardous waste. Current practice at the Pearl Petroleum site relies on a third-party contractor to transport used oils to Asia Oil and Dubai Oil facilities at Diyala for reprocessing. Other hazardous wastes (for example batteries and waste liquids) are stored in a temporary waste storage facility at the site. Batteries are removed from the site by a third-party contractor for processing and reuse.

Table 2-7 Waste management at the existing Pearl Petroleum KM facility (CPDG, 2018h)

Waste management description	Description of waste	Destination
Existing landfill	Food, cardboards, used water bottles, foam products (plates, cups)	Collected by approved third-party waste contractor for offsite management
Recycled and reused	Barrels and scrap metals	Collected by approved third-party waste contractor for offsite management
	Used lube oil	Collected by approved third-party waste contractor for offsite management
	Batteries	Collected by approved third-party waste contractor for offsite management
	Electric waste	Collected by approved third-party waste contractor for offsite management
	Tyres	Collected by approved third-party waste contractor for offsite management
	Electronic office equipment (printers etc)	Donated to Chemchemal schools
	Wood	Reuse for animal shelters and landscaping (tree support)
Incineration	Used filters	Collected by approved third-party waste contractor
	Medical wastes	Sardam Hospital
Evaporation	Produced water	Produced water evaporation pond (lined)
Treatment	Sewage	On-site STP

2.8.4.1 Construction phase

The construction camp will generate non-hazardous domestic waste including food waste, plastic and glass containers, wastepaper, card and wood. Segregation of these wastes will be implemented following current KM site recycling practices. Construction activities will generate non-hazardous inert solid wastes (for example packaging waste). Surplus excavated soil will be spread over the Project site. Scrap metal and wood may be reused on-site or transported for recycling.

Construction will generate hazardous waste such as batteries, tyres, hazardous substance packaging waste, oil filters, paint and used PPE. These will be handled, stored and disposed in accordance with Pearl Petroleum's Waste Management Procedure (WMP), the EPC Contractor Waste Management Plan and current KM site practice. Project waste lube and hydraulic oils generated by maintenance of construction equipment will be contained in a slop tank prior to being sent offsite for recycling.

Further details on expected construction waste will be provided during the EPC phase of the Project.

2.8.4.2 *Pre-commissioning and commissioning phases*

Wastes generating during pre-commissioning are expected to be similar to those generated during construction, but much lower in quantity. Commissioning phase wastes will be similar to those generated during the operations phase of the Project, but in lower volume as the pre-commissioning has a much shorter duration than the operations phase.

2.8.4.3 *Operations phase*

The operations workers camp and on-site offices will generate non-hazardous domestic waste including food waste, plastic and glass containers, wastepaper and card and wood. Hazardous waste including empty chemical drums as well as clinical waste medical or first aid treatments will be generated.

Maintenance during major maintenance shutdowns could generate hazardous wastes including spent catalyst, molecular sieves, chemicals, used filters, spent solvent, scrap metal and paint. Solids residues from the evaporation pond may be periodically removed as hazardous waste. Waste lube and hydraulic oils generated by maintenance will be contained in a slop tank and sent offsite to an appropriate treatment facility. Hazardous wastes will be handled, stored and disposed in accordance with Pearl Petroleum's Waste Management Procedure. Maintenance of equipment containing gas, condensate or LPG will result in some flaring of inventory preceding maintenance of this equipment. This may be required on a fairly regular basis as reciprocating machinery will in particular need regular maintenance.

Types and volumes of waste expected during the operations phase are expected to be similar to those generated by current KM site operations (see Table 2-7).

Pearl Petroleum estimated that based on current KM site operations, the KM250A incinerator will receive fluorescent bulbs, medical wastes and filters. However, KM250A Project medical waste is only expected to be 20% of the quantity currently incinerated, and filters about 40%.

2.8.4.4 *Decommissioning phase*

Towards the end of plant life, Pearl Petroleum will prepare a Decommissioning Plan to identify any equipment fit for refurbishment and reuse elsewhere. Hydrocarbons and chemicals removed from the site will be disposed of properly as hazardous waste. Structures and paving will be demolished, and the resulting waste materials removed from the site as inert waste.

2.8.5 Visual effects

During the construction phase, construction cranes may be visible from nearby villages during the daytime. Night lighting of cranes and Project structures similarly may be visible. This will be the case for all Project phases once the flare towers are installed.

During routine operations flare pilots, which will burn continuously, produce much less light and therefore not likely to be visible at night at nearby villages. During operations, the HP and LP flares will only be used for start-up, maintenance venting, process upsets and emergencies. The LLP flare (which will receive condensate storage tank vent gas) will be in operation on a more or less continuous basis. The volume of flared vent gas is expected to be small, therefore the flame would not be expected to be visible at nearby villages.

During emergency (unplanned) situations, flare flames will be visible when lit; the visible impact will be particularly noticeable at night. The height of high-level flares during shutdowns of the gas treatment trains will determine the distance from which they are visible. When process gases are flared, the flame of an 50 m high flare would, typically, be visible at 30 km from the site under clear atmospheric conditions.

The various Project fractionation towers (including the de-propaniser and de-ethaniser may be visible during the day at surrounding villages, and at night because they will feature lighting for worker safety.

2.8.6 Traffic

2.8.6.1 Construction phase

As discussed earlier (see Section 2.6.1.6), all earthworks at the Project construction sites will be addressed with materials currently in site i.e. cut and fill balanced. Aggregate and structural fill material will be transported from a local quarry. The estimated volume required (and the number of truck journeys per day) will be further defined during the EPC stage. Project transport would involve movement of light vehicles and heavy vehicles each day to deliver equipment and materials for construction at the Project site.

Traffic management plans and transport safety arrangements have been established for existing operations; these plans and arrangements will be applied to all phases of the KM250A Project. Measures implemented within the framework of these plans include driver training, vehicle equipment specification, in-vehicle monitoring, and regular awareness-raising through stand downs and safety meetings. Tanker driver training is included. All tankers undergo thorough visual inspection on entry to the facility; any non-compliant vehicles are not allowed entry.

2.8.6.2 Operations phase

Various products will be transported to the site on a regular basis, including approximately DEA (the volume required is based on an estimated 0.0525 kg/h consumed). Molecular sieve will be delivered to the plant periodically (approximately 3 x 56 m^3 every three to four years). Buses and cars will be used throughout the plant's operational life for the transport of the workforce. During operations 80 to 100 persons will be employed; majority of this workforce will be present for the day shift only. Transportation of the workforce will in general be done by small buses.

No deviations are expected from the current transport routes for condensate and LPG export. Additional vehicle traffic will exist along these routes due to increased production of condensate from the site. No additional LPG traffic is expected as net export volumes from the site will remain at current levels in light of demand levels. Furthermore, a new truck access route around the site will be installed.

2.8.6.3 Decommissioning phase

In addition to transport of workers, scrap and other materials will be hauled from the site to appropriate disposal destinations.

2.8.7 Land use

2.8.7.1 Construction phase

All construction activities will occur within the existing site, except for activities related to the installation of flowlines between the production wells and the plant.

2.8.7.2 Operations phase

There will be no change in land use during the operations phase of the Project.

2.8.7.3 Decommissioning phase

The plant is expected to be decommissioned once Pearl Petroleum judges that the design life has been attained. Options for restoration and reclamation will be identified and assessed at a future date, in collaboration with the competent authorities and following stakeholder consultation.

2.9 Future development

The KM reservoir has the potential to

- increase gas plant capacity up to 2500 MMscfd above the current sales gas export capacity of 420 MMscfd
- produce up to 400,000 bpd of oil.

Development of the KM250A Project will take into consideration the potential for future expansion by adopting a phased approach. Subsequent to completion of the first gas processing train (KM250A Project) and subject to gas demand in the KRI, additional gas processing trains (which will be identical to the first gas processing train) may then be installed. The current indicative plan includes the following:

- As part of the first phase of the expansion following the KM250A Project, sales gas expansion will be through the addition of a second 250-MMscfd gas plant based on a standardised design with the KM250A Project, including common utilities and common product export facilities.
- LPG recovery will initially be minimised as there is insufficient demand but have the flexibility to be maximised in the future.
- Additional sales gas capacity will be routed by a new common user pipeline from KM via Chemchemal and Erbil to the Turkish border for export to Turkey and supply of power stations at Dohuk and Zakho.
- LPG and condensate will be exported by pipeline to a new storage and distribution centre at Chemchemal to minimise truck movements to the remote KM location.

These future developments are not within the scope of the current ESIA; it is assumed that these expansion projects will be subject to separate ESIAs.

2.10 Associated facilities

Associated facilities are defined by the International Finance Corporation (2012) as '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.' Five new production wells (PW_KM_Dev1 though Dev5) will be developed in association with the KM250A Project, at the preliminary locations specified in Figure 2-4. The five new production wells will be subject to an additional detailed Environmental and Social Impact Assessment (ESIA). Potential impacts and associated mitigation measures to reduce potential impacts associated with the production wells are presented in Section 5.11 and 6.8, respectively.

The well locations have been selected based on a review of satellite imagery, geomorphological mapping and the results of seismic studies that indicated the potential for hydrocarbon reserves. Development of these wells will be sequential.

The technical description of development of each of the wells will be similar, and will be in line with the following general steps:

- site clearance and construction and/or upgrading of well pads and access roads
- mobilisation (drilling rigs and auxiliary equipment and facilities)
- drilling operations
- demobilisation (removal of all other equipment and restoration of the surrounding site to its original condition).

2.10.1 Site clearance and mobilisation

An expected area of approximately 3,200 m^2 will be dedicated to drilling operations at each well site. The well sites will be cleared of rocks and any vegetation and then graded. The surface soil that is removed will be stockpiled at the edge of the worksites; these soils will be used for backfilling after completion of the work to aid in restoration of the area to its original state. Erosion/siltation controls in the form of silt fences or similar will be erected in areas where soils are to be removed to prevent impacts on nearby sensitive environments. A fence will be constructed around the well sites to limit access by local populations, livestock, and/or wildlife to the extent possible.

The well site (including base camp) will be appropriately graded so that rainwater flows away from the work areas. Rainwater accumulating on-site will be visually inspected. Surface skimming and/or sorbents will remove oil and other pollutants, which will be stored with other waste material for disposal at a designated offsite facility. Uncontaminated water will be allowed to leach into the underlying sediments for groundwater recharge or placed into the waste pits.

When the locations of the wells have been finalised, Pearl Petroleum will carry out a detailed survey to find access road routes that reduce the requirement to clear vegetation or to fell mature trees and trees that are of economic benefit to local people. The road will be compacted, graded and surfaced with gravel, forming a strip of land approximately 6 m wide that can support heavy vehicles. The access road will be designed to avoid obstruction of drainage of the area or increase the likelihood of localised flooding. As necessary, the road will incorporate conduit pipes or other features that will allow annual water flows to cross the line of the road without obstruction.

Auxiliary facilities at each well location during drilling will include worker and OPF base camps, diesel power generators, chemical storage, laydown areas (especially for pipe strings), and a (temporary) flare. The well sites will also feature rainwater drainage, wastewater treatment and soak away pits, parking areas, an explosives bunker, aboveground diesel storage tanks, compressors, drilling mud product processing area, a flare pit, and a guard shack.

Power required for the camps and well site will be sourced from primary and backup diesel generator (DG) sets, including stacks for exhaust emissions. These generators will likely have ratings of 400 to 600 kVA each. The DG units will run 24 hours per day.

At each well site, fuel will be stored in two storage tanks within dedicated areas equipped with spill containment measures to contain any unplanned discharges (spills and leaks). The fuel dispensing area will be constructed with impervious flooring and/or drip collection trays will be provided adjacent to the vehicle fuel storage area. Diesel tanks will have secondary containment with a berm perimeter and a 2 mm high density polyethylene (HDPE) liner able to contain 110% of the largest tank volume. Oil spill clean-up kits will be placed at strategic locations.

A maintenance workshop will also be installed. Materials and spare parts will be stored in containers.

2.10.2 Drilling

Drilling of each well will require approximately 75 days to complete, if conducted 24 hours per day. A detailed drilling program has not yet been developed. The drill rig consists of typical mobile land-based drilling units. The rig will be equipped with standard operational and critical safety devices that meet industry best practices and company requirements.

Drilling typically proceeds by applying the weight of a drilling assembly and rotating the drill string to turn a drill bit at its lower end. The drill string is typically made up of 9 m sections of hollow drill pipe, and a bottom hole assembly including drill collars and down-hole measuring equipment. The drill bit has a larger diameter, so that an annular space is formed around the drill pipe as drilling progresses. The drill string is rotated by the rig's rotary table or by using a down-hole motor driven by the drilling mud (see below) circulation. The drill bit cuts into the rock formation and detaches cuttings. Water-based drilling mud is pumped into the drill pipe and through nozzles in the drill bit. The drilling mud flushes the cuttings up through the annular space between the drill string and the borehole wall and carries them to the surface.

At the surface, mud carrying cuttings from the borehole flows down an inclined mud return line and is distributed to a rank of shale shakers. The shale shakers have vibrating screens that separate rock cuttings from the drilling mud. The mud passes through apertures in the shale shaker screens, and through a sequence of tanks (including a sand trap) where equipment (mud cleaner and centrifuge) and settling removes small particles of rock from the circulating mud. The mud is then recycled through the well.

The separated drill cuttings and solids are discharged initially into an excavated, lined waste pit on-site. The well will be vertical. Once a section has been drilled to its target depth using a drill bit of a given diameter, a tubular steel casing is run into the hole and cemented in place. Subsequent sections are drilled with smaller diameter drill bits.

Reserve pits are being considered for collection of drill cuttings and drilling fluid from the operating rig. The proposed pits will be open-top and lined with impermeable geo-membrane liner. The volume of cuttings pits at each well site will be approximately 5,200 m^3. The pits will be used for disposal, dumping, or storage of fluids, wastes, or other debris and fluids used or recovered while drilling and completing the wells. The pits will not be located within or near any water bodies or groundwater recharge or pumping zones. They will be located such that they do not block natural drainage patterns. Fluids from these pits will evaporate into the atmosphere during drilling and testing operations. The pits will be of sufficient size to contain all the cuttings and fluids expected from the drilling operations. In the case of stimulation/completion activities, the pits will be tested to ensure the absence of any contaminants. Once this is confirmed, HDPE liners will be placed over the top of the pits to enclose them. The pits will then be backfilled and compacted using previously stockpiled surface soil and topsoil. The reclaimed pits will be surface sloped, as practicable, to promote surface drainage away from the reclaimed pit area.

Flare pits will be constructed and available as needed. The pits will be concrete-lined and waterproof, and of sufficient capacity to collect any produced water or condensate collected from the bulk gas stream upstream of the flare. Once the flare pits are no longer required, they will be backfilled and compacted using previously stockpiled soil. Pitless drilling is also being considered.

A water supply pit of approximately 5,000 m^3 capacity will be installed at each well site adjacent to the well pad, but outside of the berm for the well pad. Water will be supplied from existing or drilled water wells in the vicinity of the respective well sites. Upon completion, the lining of the water pits will be removed and stored for future use. These pits will be subsequently backfilled and compacted using stockpiled soil.

There will be an OPF camp constructed off the well pad along the access road to the well site at each of the five production well sites. Each OPF camp will accommodate about 45 people. Power for the OPF camp will be supplied using a diesel-powered generator.

Blowout preventer systems will be installed at the wellheads to prevent fluids from unintentionally escaping from the boreholes. American Petroleum Institute rated rams and annular preventers and drilling spools equipped with outlets for the choke and kill lines will also be used. In addition, blowout preventer stacks and diverter elements will be used for drilling of the surface hole sections. The well test package shall be equipped with an integrated emergency shutdown (ESD) system, capable of securing the well in an emergency. A testing programme (approximately two weeks) shall be conducted rig-less.

Rig components include the mast, the draw work, a rotator table, a top drive, mud pump, engines, and supporting generators. The rigs will have the following support equipment in addition to the diesel engines: pickup trucks, a crane, a forklift, a cherry picker, an ambulance, a passenger bus, a water truck, light plant generators, and a welding machine. Welding machines will also be in use at the well sites and will run on diesel. Some light vehicles may run on gasoline.

Drilling mud, which is required for lubrication of the drill bit and for removing cuttings from the drilling face, will be water-based. Drilling mud will contain the following main components: brine (base fluid), soda ash (for calcium removal), sodium chloride, caustic (for pH control), xanthan gum (for viscosity control), and an H_2S scavenger. The specific drilling mud formulations for the lower portion of the hole will be adapted during drilling operations depending on the type of material encountered during the drilling operation. The drilling mud typically contains 80% water and the drill cuttings contain about 20% water.

Two drilling mud tanks, to be hydrotested before the operation to ensure integrity, will be installed. Mud tanks will have secondary containment with a berm perimeter and a liner of HDPE (2 mm thickness) able to contain 110% of the largest tank volume.

All produced water will go to the wastewater pit, as described above.

In total, approximately 20 to 50 m^3/hour of industrial quality water will be required for drilling. Potable water will be sourced from existing drilled wells or new wells to be drilled with the water pumped to end users by pipeline. Daily peak potable water consumption will be approximately 480 L per person, or approximately 150 m^3 per day total. Additional water for drilling fluid will be used. A series of water storage pits located on and off the well pad will hold a combined total of 5,000 m^3. Water storage capacity will be provided by tanks installed at the base camp. There will be three water tanks, each with 40 m^3 capacity.

The drilling program will require a work force of employees for manning the drilling rigs, base camp operations (maintenance, kitchen, and housekeeping), and OPF operations. To the extent possible, local people from within and around the project area will be selected based on their skill sets and experience. Drill crews will be trained on HSE topics, including necessary environmental requirements and the need to respect the rights and interests of land owners and land users prior to the start of the drilling operations. There will be approximately 100 people at the well site during the day; this includes technical personnel, office workers, site logistics personnel, and security personnel.

A drill rig camp will be established at the well site at the same location as the base camp to support the drilling operations. The drill rig camp will be located at the actual well site and will be sized to minimise environmental impacts. The drill rig camp will be powered by generators and house approximately ten people. Other site workers will be transported to and from the well site daily from the main KM gas plant site or surrounding communities.

Traffic volume during drilling operations will be light, consisting of transport vehicles for workers and supervisory staff taking approximately 10 to 20 journeys each day. Traffic will increase during short periods of mobilisation and demobilisation (of people and equipment) as well as during certain drilling activities, including, but not limited to, casing installation and cementing and well stimulation. These higher volume traffic periods will involve the mobilisation and demobilisation of the drill rig and support equipment as well as the delivery of supplies needed for drilling.

The movement of equipment and vehicles associated with drilling operations will adhere to all local traffic ordinances and laws. About 30 cars or light vehicles (mostly light pickups) and 15 heavy vehicles could be expected to be deployed for the proposed drilling operations at the well site.

Once hydrocarbons are reached, well completion will be implemented. This usually involves installing production tubing to isolate production from the well annulus. Following well completion, the wells will be capped. Flowline connections will eventually be installed. Extended well tests will not be required. Short-term testing of discrete sub-surface zones will require approximately 15 to 30 days. Stimulation of the well with an acid treatment may be used to improve performance.

2.10.3 Demobilisation

Once drilling has been completed, the well site will be returned, to the extent possible, to its original state and allow original uses to take place (including possible herding and habitat for fauna). A small concrete pad to which access will be restricted will be left in place directly surrounding the wellhead. All pipelines connecting the wellhead to the nearest flowline will be underground. All residual water and oil in the pits (should the pit option be selected) will be removed before the well sites are restored to their original state. Once dehydrated, inert fly-ash, lime, or bio-remedial media will be mixed in with the cuttings and other wastes to serve as a bulking agent.

2.10.4 Emissions, discharges and wastes

Construction and drilling activity, including construction equipment operations, drill rig operations, and the operation of support equipment, generators, and vehicles, are expected to produce air pollutants through their emissions. Primary pollutants produced from emissions associated with this work will include CO, CO_2, NOx, SO_2, H_2S, VOCs and particulate matter.

Dust emissions may be generated from earthwork during pad and camp preparation or upgrading, access road upgrading, and the movement of vehicles. If required, water will be spread over unpaved or dirt roads to suppress dust generation, particularly during summer months. Furthermore, all vehicles will operate in a responsible and mindful manner with a goal of keeping dust generation to a minimum.

Oil and gas, possibly containing H_2S and CO_2 will be flared at the well site during drilling and testing operations. The gas flared is expected to consist of mostly methane, with the balance consisting of ethane, propane, butane, pentane, H_2S, and CO_2. The flare exhaust will include SO_2 emissions from the oxidation of H_2S that occurs in natural gas. Up to 600,000 m^3 of gas will be flared each day based on the capacity of the well test system for each well. As per current program, well testing will only consist of a cleaning operation with an expected 1 to 3 days of flaring. A contingency program is being developed with plans to drill into deeper formations on one well. This may entail a full short term well testing program.

Elevated noise levels are expected from the construction equipment, explosives use, drilling rigs, generators, and vehicles. The primary sources of noise during drilling are mechanical equipment, drilling rig and auxiliary equipment, and support trucks and vehicles. The transport of people and materials to the work areas will also increase ambient noise levels. In addition, noise will result from operation of the mobile DG units used for power.

Sewage (black water) and wastewater (grey water) from the worker camp will be diverted to an on-site sewage wastewater treatment facility. The wastewater treatment unit will remove solid waste/sludge, and the wastewater will then be discharged into a leach field following on-site treatment.

Separate collection areas for restricted and non-restricted waste will be provided at the camp. All restricted waste will be stored and secured in an area within the camp pending identification of a suitable disposal facility or other appropriate treatment option.

Drill cuttings management will reflect the best practicable environmental option.

2.10.5 Schedule

The required ESIA for the five wells will be completed during Q2 to Q3 2020. Drilling of the first well is expected to take place in Q4 2020. The wells will be capped when drilling has been completed and will come online at the expected KM250A gas plant start-up in Q1 2022.

3 BASELINE PROPERTIES OF THE ENVIRONMENT

3.1 Methodology

The baseline studies were conducted using a combination of secondary data (desk-studies and data collected by others) and primary data (field surveys conducted by RSK).

The desk-based portion of the baseline study was undertaken through a review of various documents and data sources that are referenced in the text. These included the following ESIA and baseline studies, and various sources of information listed in the references (Section 12):

- Environmental Social Impact Assessment Report (KM-9, KM-10 and KM-12) Khor Mor Block, (MapCom, 2018)
- Khor Mor Gas Plant: Environmental Impact Assessment, (ERM, 2015)
- Environmental Baseline Survey, (MapCom, 2010)
- Kurdistan Gas Project Environmental Impact Assessment Volume i: Gas Pipeline from Khor Mor to Erbil, (WorleyParsons, 2007).

Field surveys were undertaken in cases where existing data and information were deemed insufficient, for noise, air quality, water quality, soil quality, and biodiversity, in order to supplement desktop data and information (including information from previous studies) and ensure that local data and information is up to date. Field survey methodology is described in the sections below.

The area of influence (AOI) was defined for various topic areas based upon the definitions given in the International Finance Corporation (IFC) Performance Standard (PS) 1 and represent the geographical area expected to be affected by:

- impacts (direct and indirect) arising from Project activities and facilities (this includes the Project site, flowlines, well pads, and road transport network used for the transportation of personal and materials)
- impacts from unplanned, non-routine events
- indirect impacts on biodiversity or on ecosystem services that are linked to the livelihoods of affected communities
- associated facilities consisting of five new production wells
- cumulative impacts.

The AOIs were used to guide baseline development and provide focus for environmental and social impact assessment (ESIA) baseline activities. The specific AOI is presented under each specific topic.

3.2 Physical environment

3.2.1 Geography, climate and meteorology

3.2.1.1 Geography

The Khor Mor site is located within the Garmiyan Administration of Sulaymaniyah Governorate in the Kurdistan Region of Iraq (KRI). The Sulaymaniyah Governorate is one of four governorates in the KRI. The study area is situated within Qadir Karam sub-district, Chemchemal district.

The Khor Mor existing facility is located at an approximate elevation of 450 m above sea level. The general area is characterised by very rugged topography with anticlinal mountains. In the Khor Mor area, the landscape is primarily rocky and barren with narrow valleys, ridges, hills, slopes and plains. Surface water bodies are relatively rare and generally seasonal.

3.2.1.2 Climate and meteorology

Generally, the climate of the KRI is described as continental and subtropical semi-arid type, characterised by wide diurnal and annual ranges of temperature, low relative humidity, and cloudless summer months. The climate in the Khor Mor area is generally characterised by hot dry summers and cold winters.

Meteorological data of the Chemchemal district were reviewed from January 2009 to August 2019 (World Weather Online, 2019). The annual average temperature in the Chemchemal area from 2009 to 2019 was 19.7°C, with an average minimum temperature of 15°C and an average maximum temperature of 25°C. The average wind speed in the Chemchemal area in 2018 was 8.9 km/hour. Light winds (<20 km/hour) are most common from May to July, whilst the highest frequency of strong winds (41-61 km/hour) occur from September to January. The prevailing wind direction is from the south-west to north-west. The region is prone to dust storms in the summer. The annual average precipitation in the Chemchemal area from 2009 to 2019 was 367 mm, with an average of 82 rainy days a year. There is also an average of 2.6 snow days a year, with an average of 3.5 cm of snowfall.

3.2.2 Geology

3.2.2.1 Structural geology

The Khor Mor site is located within the Foothill Zone of the Unstable Shelf in Kurdistan (Jassim & Goff, 2006). The series of anticlines and synclines trend in a north-west to south-east direction.

3.2.2.2 Stratigraphy

The surface geology in the block comprises primarily Tertiary and Quaternary age units. Further details are provided below.

3.2.2.2.1 Upper Fars formation (Tertiary formation)

The Upper Fars formation mainly consists of alternating beds of sandstones and mudstones, which are reddish brown to light brown in colour, bedded or massive, and fractured/jointed. This formation contains some carbonate veins, iron oxides, and slickenside surfaces. This is rich in sedimentary structures, including lamination, graded bedding, mud balls, ripple marks, cross bedding, borings, and burrows. The Upper Fars formation is Late Miocene in age (Bellen et. al., 1959). The sediments of the Upper Fars formation were deposited in transitional and fluvial environments. Geomorphologically, the formation forms hilly areas with continuous strike ridges and valleys due to the alternation of hard and soft rocks. This formation constitutes much of the surface outcrop in the Khor Mor concession (Pearl Petroleum, 2018).

3.2.2.2.2 Lower Bakhtiari formation (Tertiary formation)

The Lower Bakhtiari formation is composed of 2,000 m of fining upward cyclic deposits of gravelly sandstone, sandstone, and mudstone. Mudstone makes up about half of the total thickness. The depositional environment for this formation was a rapidly subsiding foredeep basin (Bellen et al, 1959). This formation is exposed at the surface in the north-western portion of the Khor Mor Block.

3.2.2.2.3 Upper Bakhtiari formation (Tertiary formation)

The Upper Bakhtiari formation consists of molasse sediments of alternating deposits of claystone and conglomerates with some sandstone and siltstone beds. The conglomerates make up most of the formation, forming more than half the thickness of the formation in the upper parts. The pebbles in the conglomerates are spherical, bladed and rod shaped, varying in size from less than 1 cm to up to 15 cm. Sand and calcareous material cement the pebbles in the conglomerate layer. Lenses of sandstone are common in the conglomerate.

This formation represents the youngest formation outcropping in the Khor Mor Block. Relative to other formations and deposits, this formation occupies the largest surface area exposure within the Khor Mor Block.

Locally, these land areas are anecdotally called "Bad Land Areas." The Upper Bakhtiari formation is of Middle Pliocene age. The depositional environment for this formation is alluvial fans originating from the High Folded Zone and the Zagros Suture.

3.2.2.2.4 Quaternary deposits

Polygenic deposits are Pleistocene to Holocene in age, and include clay, silt, gypsum, sand, and gravel. These sediments contain large and angular rock fragments, which are restricted to slopes and are formed due to large rock falls or collapse. Rock fragments are subsequently cemented by clayey and calcareous materials. The fragments are of different types of limestone with angular edges and are of various shapes and sizes.

Slope deposits (Pleistocene-Holocene) occur in the Block as either angular rock falls on slopes of hills or rounded gravels. The thicknesses of these deposits range from 20 to 60 m. These deposits cover a fairly sizable area in the north-western quadrant of the Block.

Valley-fill sediments (Holocene) cover extensive valleys between anticlinal ridges. These sediments are accumulated as thin beds with varying size particles, depending on the geological properties, types of rocks exposed, and climatic conditions. Valley-fill sediments consist of mixtures of clay, sand, and pebbles.

3.2.2.3 Seismicity

Tectonically, the KRI Iraq is located in an active seismic zone, thus it experiences an appreciable level of earthquake activity. Th KRI is directly influenced by the seismicity of the Alpine-Himalayan orogenic system (Zagros-Tauros range). This system, identified with high mountain ranges and shallow, somewhat diffuse seismicity constitutes one of the most seismically active continental regions of the world with a long and well-documented history of earthquakes. The KRI is rated ‘very high’ for seismic hazards by the World Health Organisation (WHO, 2010). Oil Serv (2018) conducted a seismic investigation at the KM250A Project site and reported that the site is located in a Zone III seismic zone.

3.2.2.4 Past field data collection at the Project site

A site investigation was carried out by Map Group in May 2019 to collect geotechnical data in the area of the proposed KM250A facility and plant. Boreholes were excavated to a maximum depth of 10 m below ground level (thus concerning shallow ground for Quaternary deposits; see previous section). The borehole logs suggest that the shallow ground consists primarily of silty clay overlying siltstone and claystone.

3.2.3 Soil

3.2.3.1 Area of influence - soil

The AOI for soil is summarised in Table 3-1.

Table 3-1 AOI - soil

Topic	Construction phase	Operations phase
Soils	The physical footprint of the Project to reflect the disturbance of soil within newly developed areas of the main site and along the flowlines.	None

3.2.3.2 Description of soil types

Desk study and previous findings

A soil map for Iraq is presented in Figure 3-1. It indicates that the general region of the Project site is characterised by rough broken and stony land or brown soils.

Soil formations in the Block include alluvium, fluvisols, mollisols, calcisols, and mountain soils that are generally brown in colour (MapCom, 2018). The surface layer is approximately 50 to 60 cm in thickness, and the soil has a total depth ranging from 50 to 150 cm. Soil texture ranges from silty clay to sandy clay. The pH of the soil varies from 8.1 to 8.5. Electrical conductivity of the soil is high. The soil has a high calcium carbonate ($CaCO_3$) content at the surface (~26%) that decreases with depth.

The presence of organic matter in the soil is low due to present land uses in the general Project area, including grazing and burning of crop residues. Soils with higher organic matter are characterised by dark topsoil and are classified as a mollic horizon. In addition, calcisols are also known to be present in the area.

The soils tend to be self-mulching[3]. Due to the low organic content, soil crusting also occurs, but not to the extent that seedling emergence is impeded. The vertic[4] properties

[3] A soil that mixes itself: its surface layers shrink and swell, forming deep cracks into which soil falls.

[4] This term is used to describe a subsoil with a field texture of 35% or more clay that experiences significant shrinking and swelling, resulting from drying and wetting.

of the soil are not sufficiently developed for a true vertisol. This is likely due to the high $CaCO_3$ content, which tends to suppress the swelling behaviour of the clay.

Upland/hilly soils in the Block consist of deep, brown soils and deeply eroded brown soils. These brown soils yield important dry farming lands upon which wheat is grown or which are used for grazing. The thickness of the soils varies with relief, whereby the deepest soils exist on level plains and the shallower soils exist on the upper slopes and summits of hills. Leaching and accumulation of lime and swelling and shrinking of clays in the upland areas are generally more pronounced than in the plains and valleys. The lime accumulation horizon tends to start slightly deeper in the upland areas than in the plains and valleys due to higher rainfall in the upland areas.

In the valleys and river embankments, the soil is mainly alluvium consisting of gravel and sand. The fluvisols present in the block have visible stratification and irregular amounts of organic material.

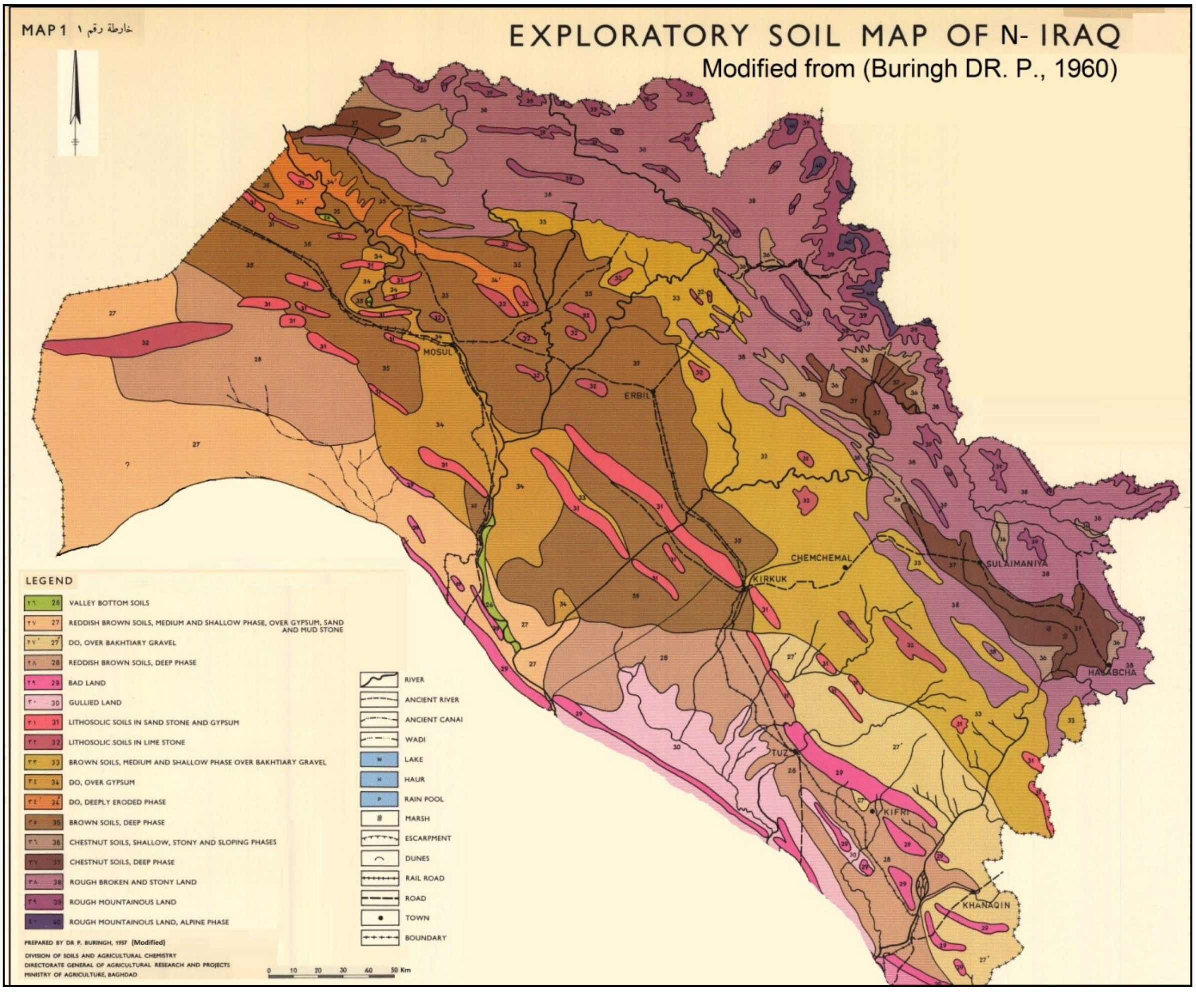


Figure 3-1 Soil map of Iraq (Buringh, 1960)

3.2.3.3 *Past field data collection in the Project area`*

Historical soil sampling within the soil AOI has not been conducted. However, soil sampling was undertaken by MapCom at four villages (Qarah Chewar, Zhazh, Mamisik and Sheik Jalal) outside AOI in the Khor Mor region and at the existing KM site (2010).

Shallow subsurface soil samples (depths between 0.15 m to 1 m) were collected using a stainless-steel hand auger. The results (see Appendix 1, Table A1.1) indicated concentrations of cadmium exceeded the Project Standard (Appendix 3 Table A3.1) in two locations (Zhazh and Shekh Jalal). None of the parameters exceeded the Project Standard at the existing KM site. The MapCom report (2010) did not specify the valance of the chromium analysed. If the analysis was for chromium VI then the concentration of chromium exceeded the Project Standard at all locations.

Soil sampling was also undertaken by MapCom at three well sites (KM-9, KM-10 and KM-12) outside the soil AOI in the Khor Mor region (2018). The results (see Appendix 1, Table A1.2) indicated that concentrations of manganese and nickel exceeded the Project Standard in several location. The MapCom report (2018) did not specify the valance of the chromium analysed. If the analysis was for chromium VI then the concentration of chromium exceeded the Project Standard at all locations

3.2.3.4 *Current field data collection in the Project area*

Soil sampling was undertaken by RSK in November 2019 at thirteen locations in the AOI. Shallow soil samples were collected at a depth of no more than 0.4 m below ground level using a shovel and trowel. Locations SS1 to SS8 were selected to provide geographical coverage of the site and SS9 to SS13 were selected where future plant/facilities will be located and are therefore potential sources of contamination to soil. All locations are tabulated in Table 3-2 below.

Table 3-2 Soil sampling locations

Sample ID	Rationale	Coordinates (WGS84 38N)	
		Easting	Northing
SS1	Geographical coverage	484346	3887945
SS2	Geographical coverage	483340	3887510
SS3	Geographical coverage	484181	3887266
SS4	Geographical coverage	483599	3886433
SS5	Geographical coverage	484681	3886904
SS6	Geographical coverage	483669	3887283
SS7	Geographical coverage	483823	3887283
SS8	Geographical coverage	483923	3886816
SS9	Power generation area	484210	3886672
SS10	Hot oil system (future)	484246	3886585
SS11	Condensate stabiliser (future)	484281	3887167
SS12	Produced water treatment (future)	484060	3887549
SS13	Lined evaporation pond 1 (future)	484346	3887945

All photographs of sampling locations are included in Appendix 2 (Table A2.1) along with laboratory certificates. The sampling indicated that the soil is grey and brown silty and sandy clay with root fragments. No evidence of visual or olfactory contamination was observed at any of the locations.

Sample storage was undertaken in accordance with the RSK quality management system procedure and all samples were shipped to the Al Futtaim Element Materials Technology Dubai laboratory for analysis.

The reported concentrations of all parameters were either below the laboratory detection limit or below the Project Standard, with the exception of nickel concentrations as shown in Table 3-3. Nickel concentrations exceeded the Project Standard at all locations and may represent background soil conditions and composition. The KM250A Project will not exacerbate nickel concentrations in soil. The soil sampling locations are presented as Figure 3-2.

Table 3-3 Laboratory results of the current soil sampling survey in 2019 (mg/kg)

Parameter	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13	Project Standard (mg/kg)
Arsenic	4.1	3.6	2	2.7	3.4	4.9	3.9	3.7	4.1	2.8	3.4	4.3	3.4	20
Barium	101	123	137	112	270	134	182	99.5	95.4	91	98.6	93.8	117	-
Cadmium	<0.5	0.6	0.7	<0.5	<0.5	<0.5	<0.5	0.7	0.6	<0.5	<0.5	0.6	<0.5	3
Copper	19	21.1	20	17.9	21.7	20.5	19.4	17.6	17.1	16.8	22.1	19.7	19.7	100
Lead	8.1	9.4	7	6.7	7.1	6.9	6.2	6.2	6.5	6.4	7.6	7.9	6.9	300
Nickel	75.6	79.7	80.1	67.8	81.6	80.7	76	72.4	69.9	67.9	84.7	74.8	76.1	60
Selenium	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	-
Zinc	47.6	53.3	51.5	47.5	56.8	52.3	55.6	48.3	46.9	46.9	57.4	53.8	51.6	200
EPH C10-C40	53	<50	89	<50	72	<50	65	<50	<50	<50	<50	<50	<50	90
VPH C5-C10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-

Red – exceeds Project Standard

EPH – extractable petroleum hydrocarbons

VPH – volatile petroleum hydrocarbons

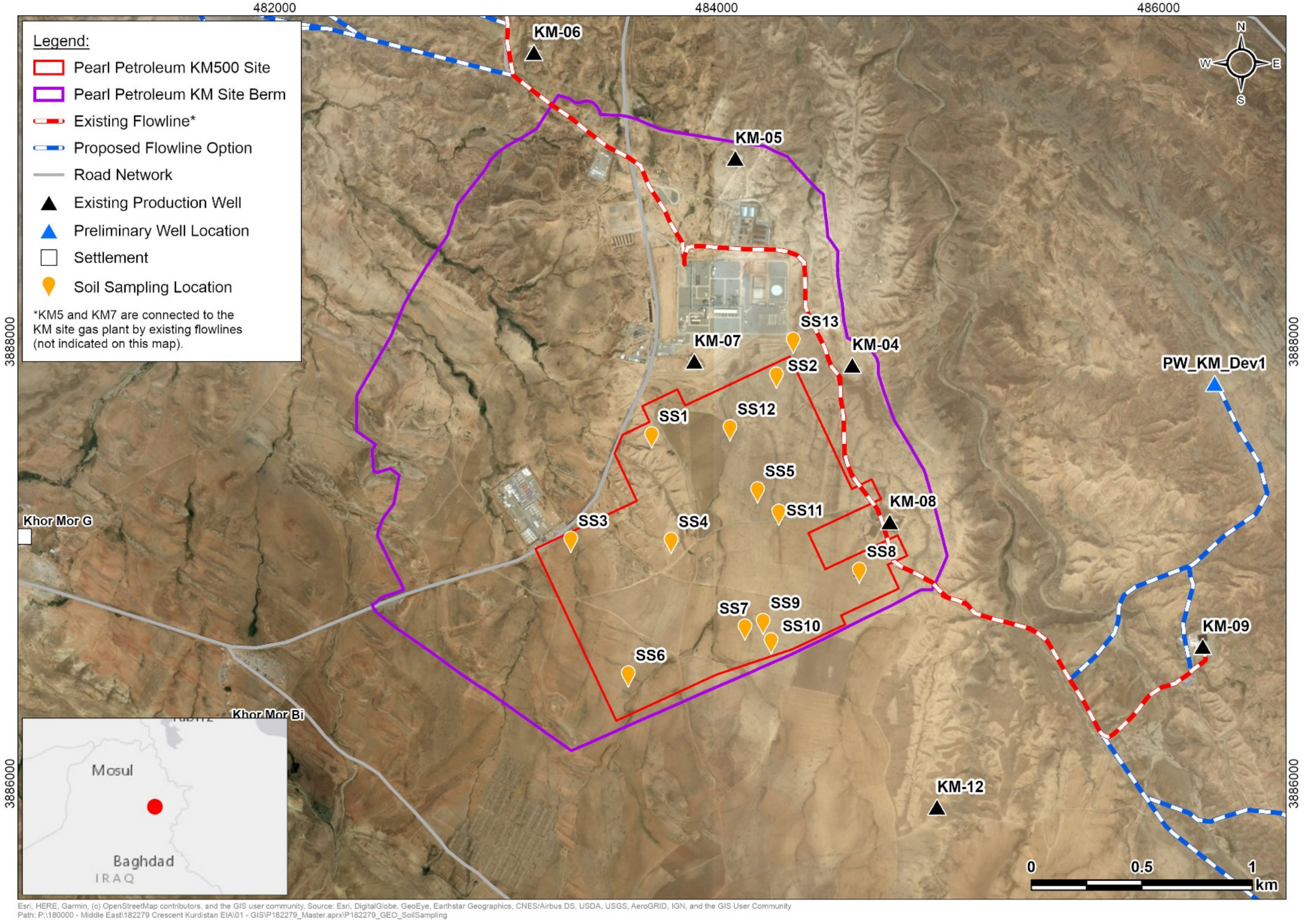


Figure 3-2 Soil sampling locations

3.2.4 Water resources

3.2.4.1 Area of influence - water resources

The AOI is summarised in Table 3-4.

Table 3-4 AOI - water resources

Topic	Construction phase	Operations phase
Surface Water	2 km radius from fenceline where changes in the surface water could occur	2 km radius from fenceline to reflect permanent physical presence of the site where changes in the surface water could occur
Groundwater	None	10 km radius surrounding the three existing boreholes to reflect the reduction in groundwater elevation from abstraction (this has been assumed to encompass a broader area covering one, or more, groundwater aquifers where impacts to other groundwater users may occur)

3.2.4.2 Description of water resources

The Awa Spi River, the only perennial river in the general Project area, is approximately 3.5 km north-west of the Khor Mor existing facility and is outside of the surface water AOI. Awa Spi has three tributaries; these and other surface water features within the general Project area are seasonal. The Awa Spi flows towards the south-west/west. Several springs are present within the AOI. The river is shown in Figure 3-3.

The MapCom (2010) baseline survey indicated that local villages generally rely on shallow wells that abstract groundwater from the Pila Spi limestone formations at depths of less than 20 m. A geophysical survey was carried out using 2D electrical resistivity methods (Aziz, 2018 and 2019) to identify aquifers near Khor Mor. The survey indicated that the Lower Bakhtiari formation, composed mainly of gravel and sandstone and located at depths of 20 m to 150 m in the survey area, can be a reliable local source of water supply for the Project. In addition, Mohammed (2019b) reported that the Upper Bakhtiari formation is also an aquifer of local importance.

Hydrogeological surveys were undertaken in January 2019 by Mohammed (2019a;b). The survey comprised hydraulic testing of three existing wells (WW1-3) located south of the Khor Mor site (Figure 3-3). The results of the hydraulic testing during the survey indicated that abstraction should not exceed a rate of 6 L/second at any of the three locations. The status of the wells is presented in Figure 3-3.

Groundwater is an important source of water for both domestic and commercial use (including shops and small businesses) in communities in the Project area. Locations of local village wells are presented in Figure 3-3. Groundwater is the only source of water for Khor Mor operations and Pearl owns some of the wells in the villages.

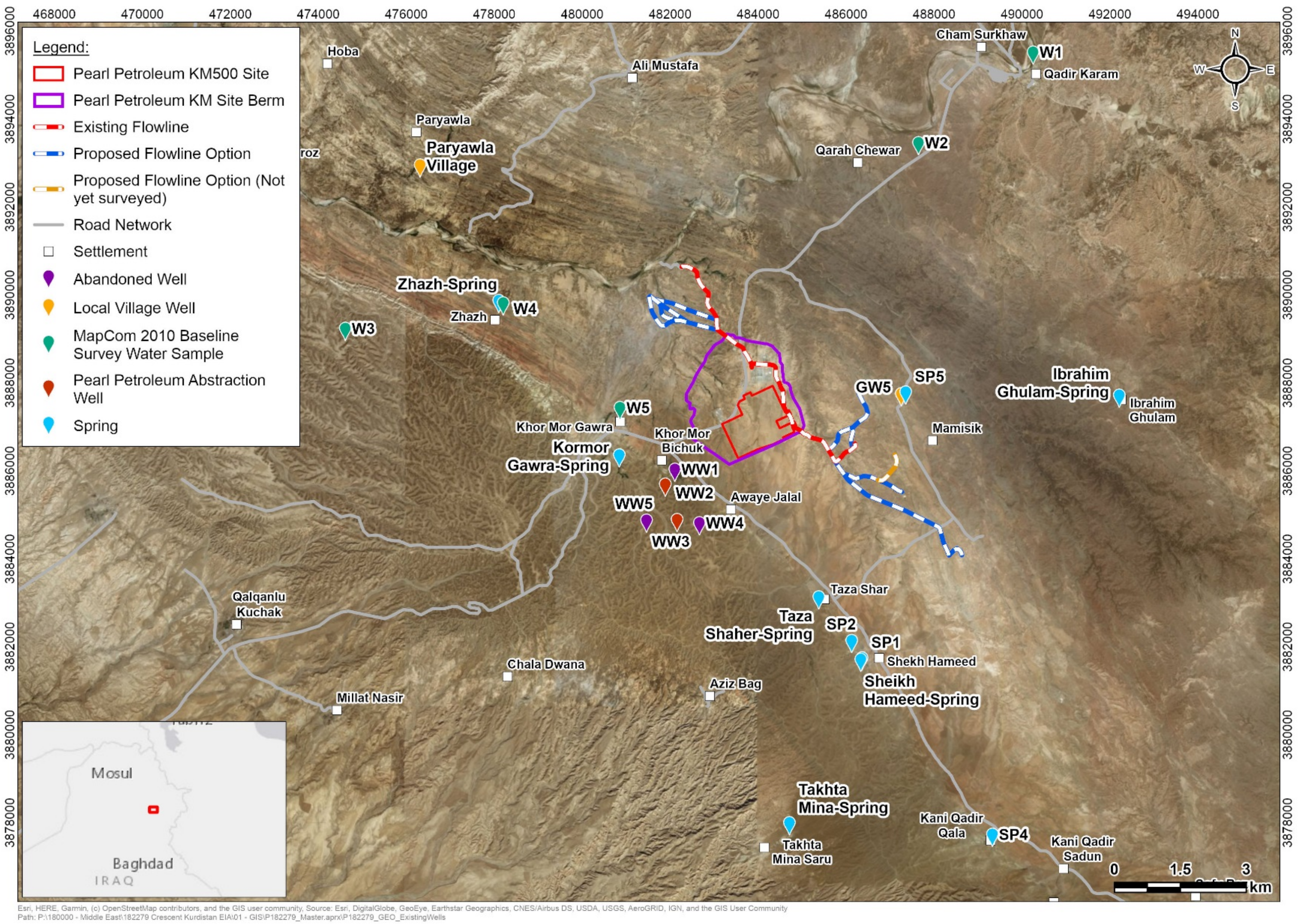


Figure 3-3 Water resources and sampling locations

Table 3-5 Status of existing abstraction wells in the Khor Mor area

Well	Easting	Northing	SWL (m)	Status	Lithology/formation name	Abstracted volume (L/week)
WW1	482105	3885755	11	Temporarily abandoned	Upper Bakhtiari (claystone/siltstone/sandstone)	No data
WW2	481888	3885416	36	Operating	Upper Bakhtiari (claystone/siltstone/sandstone)	22,082,000
WW3	482156	3884612	32	Operating	Upper Bakhtiari (claystone/siltstone/sandstone)	1,635,000
WW4	482664	3884538	NM	Abandoned	no data	No data
WW5	481461	3884598	NM	Abandoned	no data	No data

SWL – Static water level below datum

NM – not measured

Source: Aziz (2018 and 2019)

3.2.4.3 Past field data collection in the Project area

Surface water samples were taken at four locations along the Awa Spi river (locations WQ1 through WQ4) and one at a permanent surface spring to the south of the river (WQ5, just to the north-west of the KM existing facility by MapCom in 2010. Samples were analysed for key physical, chemical, and biological parameters. Results (Appendix 1, Table A1.3) indicated that BOD exceeded the Project Standard (see standards in Appendix 3, Table A3.2 and A3.3) at all four locations along the river, ranging from 8 to 16 mg/L. The dissolved oxygen (DO) Project Standard (5 mg/L) was exceeded at two sampling locations along the river and at WQ5. The Project Standard for nitrate concentrations (15 mg/L) and sulphate concentrations (200 mg/L) was exceeded at all sampling locations. Nitrates and sulphates are typically caused by runoff from agricultural areas.

Sampling of springs and water wells was also undertaken in 2018 by MapCom at the locations presented in Figure 3-3. The results were all below the Project Standards except for alkalinity and bacteriological analyses which exceeded the criteria for Total Plate Count values (Table 3-7).

Table 3-6 Water sampling locations (MapCom, 2018)

Sample ID	Easting	Northing	Notes
GW1	486362	3881466	Natural spring - Shekh Hameed
GW2	486126	3881861	Natural spring
GW4	489326	3877456	Natural spring - Kani Qadir
GW3	489,472	3,877,835	Kani Qadir Qala well
GW5	487,253	3,887,473	Surface well in Mamisik
GW6	485,609	3,883,101	Well in Taza Shar village
GW8	485,609	3,883,101	Well in Taza Shar village

Table 3-7 Summary of spring and groundwater results (MapCom, 2018)

Parameter	Minimum	Maximum	Project Standard*	Comment from MapCom 2018 report
Total plate count (colony forming units per litre)	>1000	>1000	1.1	Not suitable for drinking water at any location
Most probable number per mL	1	240	-	Not suitable for drinking water at most locations
Total alkalinity (mg $CaCO_3$/L)	106	567	500	

Red – exceeds Project Standard

Note: The colony count as measured in a laboratory is multiplied by the dilution factor to yield the total plate count. Indicator bacteria can be detected to give an estimate of pathogens. The most common indicator organisms in water bacteriology are the coliform bacteria.

Regular testing of samples of groundwater from WW1, WW2 and WW3 is undertaken by Pearl Petroleum. The samples are tested for lead, copper, iron, nitrate, nitrite, pH, chlorine, hardness, alkalinity, bacteria and pesticides. Data for the period of September 2018 to February 2019 were provided by Pearl Petroleum. With the exception of one sample, none of the results exceed the Project Standard; on 30/2/18, at WW1, copper concentrations (1.4 mg/L) exceeded the Project Standard of 0.01 mg/L and bacteria tested 'positive'.

3.2.4.4 Current field data collection in the Project area

A hydro-census was undertaken in November 2019 at the locations shown on Table 3-8 and presented on Figure 3-3. The objective of the survey was to collect baseline data within the AOI in order to characterise the groundwater and springs and their sensitivity to potential impacts. The sampling locations were identified following a detailed review of baseline studies and environmental reports related to the Project. In addition, locations were also identified based on the results of the socio-economic baseline survey undertaken by RSK. Water samples were collected by an RSK site engineer from groundwater wells and springs. The following field parameters were measured for each sample on-site:

- temperature (° C)
- electrical conductivity (µS/cm)
- pH
- DO (mg/L)
- DO (%).

A total of 14 water samples (13 locations plus one duplicate) were collected and shipped for laboratory analysis. Analysis was undertaken at the Al Futtaim Element Materials Technology Dubai laboratory with the exception of the bacteriological testing which was completed at the EnviroLab laboratory in Basra (due to the fact that the samples required testing within 24 hours). All samples were analysed in the laboratory for:

- turbidity
- selected inorganic parameters and dissolved heavy metals
- selected cations and anions
- hydrocarbons and polycyclic aromatic hydrocarbons (PAHs)
- pesticides
- bacteriological parameters (total coliforms and *Escherichia coli*).

Table 3-8 Groundwater sampling locations (RSK, 2019)

Sample ID	Coordinates (WGS84 38N)	
	Easting	Northing
Paryawla well	476313	3892673
WW2	481888	3885416
WW3	482156	3884612
Khor Mor Gawra-Spring	480842	3886081
Taza Shaher-Spring	485378	3882854
Sheikh Hameed-Spring	486333	3881433
Sheikh Hameed village (SP2)	486130	3881866
Qadir Qala village (SP4)	489330	3877453
Surface well in Mamisik village (GW5)	487354	3887512
Zhazh-Spring	478101	3889592
Takhta Mina-Spring	484711	3877719
Ibrahim Ghulam-Spring	492210	3887439

The following quality control measures were implemented to ensure that accurate and reliable data are collected:

- single use bailer sampling in wells/boreholes to prevent cross-contamination of samples
- duplicate sample was taken to check reproducibility
- use of nitrile gloves to prevent contamination of samples.
- calibration of the multi-parameter probe prior to the survey
- daily calibration checks.

Table 3-9 and Table 3-10 present the field parameter readings for groundwater and spring samples. The values are all typical of groundwater and springs. There are no Project Standards for these parameters except for pH and DO. The pH is within the Project Standard. The DO at some locations is < 5mg/L which does not meet the Project Standard (> 5 mg/L).

Table 3-9 Field parameter data for water resources (RSK, 2019)

Sample ID	Temperature (°C)	Electrical conductivity (μs/cm)	pH	DO (mg/L)	DO (%)
Paryawla well	20.1	793	8.33	0.98	10.9
	20.1	792	8.34	0.85	9.4
	20.0	792	8.34	0.83	9.1
WW2	25.2	319.3	7.56	2.54	30.9
	25.2	317.8	7.59	2.73	33.2
	25.2	317.6	7.59	2.68	32.6
WW3	24.6	290.5	7.57	6.43	77.4
	24.5	314.8	7.64	5.68	69.4
	24.5	317.3	7.74	5.45	65.5
Project Standard	-	-	6.5 to 8.5	> 5	-

Red – does not meet Project Standard

Table 3-10 Field parameter data for water samples (RSK, 2019)

Sample ID	Temperature (°C)	Electrical conductivity (μs/cm)	pH	DO (mg/L)	DO (%)
Khor Mor Gawra Spring	21.7	283.7	7.35	6.07	69.0
	21.7	279.5	7.36	5.91	67.8
	21.7	274.6	7.41	5.82	66.1
Taza Shar Spring	24.7	446.5	7.39	5.32	64.0
	24.6	424.5	7.21	4.64	55.8
	24.6	407.3	7.14	4.61	55.4
Shekh Hameed Spring	21.2	363.6	7.05	3.68	41.5
	21.1	360.8	7.04	3.49	39.3
	21.1	355.7	7.06	3.29	37.1
SP2	23.4	353.4	7.33	3.31	38.9
	23.4	353.2	7.32	3.31	38.9
	23.4	351.9	7.31	3.33	39.2
SP4	23.9	264.4	7.38	4.68	55.5
	23.9	263.8	7.36	4.56	54.1
	23.9	263.6	7.35	4.58	54.3
GW5	21.	417.6	7.43	5.67	63.6
	21	419.7	7.44	4.90	55.0
	21	420.4	7.44	4.82	54.1

Sample ID	Temperature (°C)	Electrical conductivity (µs/cm)	pH	DO (mg/L)	DO (%)
Zhazh Spring	19.6	1273	7.62	5.36	58.7
	19.6	1289	7.61	5.33	58.4
	19.6	1302	7.61	5.30	58
Takhta Mina Spring	25.7	403	7.26	2.67	32.4
	25.7	402	7.27	2.56	31.4
	25.7	400	7.27	2.46	30.1
Ibrahim Ghulam Spring	24	612	7.63	4.99	59.4
	24	604	7.62	4.55	54.4
	24	605	7.63	4.62	54.9
Project Standard	-	-	6.5 to 8.5	> 5	-

Red – does not meet Project Standard

Groundwater depth levels were measured where possible and the results are presented in Table 3-11. Photographs of all sampling locations are presented in Appendix 2 (Table A2.2) along with laboratory certificates.

Table 3-11 Groundwater depths

Sample ID	Well depth (mbtoc)	Water level (mbtoc)
Paryawla well	100	5.26
WW2	Well was covered so not accessible	Well was covered so not accessible
WW3	Well was covered so not accessible	Well was covered so not accessible

Note: mbtoc: metres below top of casing of well. No topographical data are available, so the levels were not measured in relation to a local datum.

Laboratory results for the samples are shown in Table 3-12. All samples were compared to the Project Standards (Appendix 3, Table A3.2 and A3.3). The results of the duplicate sample that was tested (WW6 and SP3) indicated that the results are reproducible.

The results indicate the presence of total coliforms at all locations which exceeds the Project Standard (1.1 colony forming units per litre) and water at these locations is not considered potable without appropriate treatment. Concentrations of chloride, sulphate, total dissolved solids, magnesium and calcium at Zhazh Spring exceeded the Project Standards. Calcium concentrations exceeded the Project Standard at several locations. No further exceedances were detected. All other parameters, including *Escherichia coli*, hydrocarbons and PAHs were not detected. The coliform levels are due to improper wastewater discharge in surrounding villages. The KM250A Project would not exacerbate this problem. Similarly, regarding the high levels of TDS, chlorides, sulphate, magnesium and calcium, raw groundwater is treated prior to human consumption, so there should be no threat to local drinking water supply. The KM250A Project will not exacerbate the low quality of raw groundwater.

In some cases, the laboratory limit of detection exceeded (mercury, cadmium and phenols) or was equivalent (chromium, selenium, arsenic and lead) to the Project Standard.

Table 3-12 Laboratory results of the current water resources sampling survey in 2019 (mg/L or as stated)

Parameter (mg/L)	Khor Mor Gawra Spring	Taza Shaher-Spring	Shekh Hameed-Spring	SP2 (spring)	SP4 (spring0	GW5 (spring)	SP3 (duplicate of SP2)	Zhazh-Spring	Takhta Mina-Spring	Ibrahim Ghulam-Spring	Paryawla Well (groundwater)	WW2 (groundwater)	WW3 (groundwater)	WW6 (duplicate of WW3)	Project Standard
Bacteriological															
Escherichia coli	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	<1.1*
Total coliforms (cfu/L)	1000	100000	100	100	100	100000	1000	10000	100000	10000	10	10	10	100	<1.1
Anions															
Chloride	7	9.5	11	10	8.5	24.5	9.5	334	10.5	20.5	50	7.5	7	8	200
Sulphate	23	33	42	61	12	66	50	437	13	97	192	33	24	36	200
Fluoride	0.5	0.4	0.3	0.3	0.3	0.6	0.2	0.7	0.4	0.9	1	0.5	0.4	0.6	-
Nitrate	0.66	0.49	1.02	0.58	1.24	1.86	0.66	0.89	1.99	0.66	2.17	0.4	0.71	0.18	15
Nitrite	0.016	0.02	0.026	0.02	<0.016	0.259	0.016	0.168	0.016	0.016	0.023	0.02	<0.016	0.02	3.0
Inorganic															
Total hardness	191	370	370	185	178	218	262	677	210	147	60	140	134	141	500
Total dissolved solids	239	328	375	341	228	444	337	1450	306	398	600	215	203	215	1000
Surfactants anionic	0.015	0.018	0.017	0.017	0.018	0.017	0.016	0.017	0.015	0.017	0.016	0.015	0.016	0.017	0.3
Turbidity (NTU)	0.1	1.8	2.8	0.7	0.3	4.3	0.7	4.7	0.9	0.4	<0.1	<0.1	<0.1	0.7	5
pH (units)	8.2	7.8	7.7	7.9	7.9	7.9	8	7.9	7.7	8.2	8.3	8.1	8.1	7.9	6.5-8.5
Metals															
Chromium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Mercury	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.001
Aluminium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
Arsenic	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Barium	0.14	0.23	0.28	0.13	0.04	0.09	0.13	0.05	0.27	0.05	0.02	0.16	0.21	0.14	0.7
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.003
Calcium	66	135	136	62.6	62.9	51.2	93.4	180	64.4	29.1	14	43	42	43	50
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
Iron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.3
Lead	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Magnesium	6.4	7.9	7.2	7	5.1	22	7.1	55.1	11.9	18.5	6.5	7.8	7.1	8.3	50
Manganese	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
Nickel	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Sodium	11.6	12.2	8	6.6	7	60.9	6.6	186	16.2	76.7	165	13.2	12.2	14.4	200
Zinc	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.5
Phenols															
Total phenols	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.002

Parameter (mg/L)	Khor Mor Gawra Spring	Taza Shaher-Spring	Shekh Hameed-Spring	SP2 (spring)	SP4 (spring0	GW5 (spring)	SP3 (duplicate of SP2)	Zhazh-Spring	Takhta Mina-Spring	Ibrahim Ghulam-Spring	Paryawla Well (groundwater)	WW2 (groundwater)	WW3 (groundwater)	WW6 (duplicate of WW3)	Project Standard
Hydrocarbons (µg/l)															
EPH C10-C40	<50	129	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
VPH C5-C10	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	-
PAHs (µg/l)															
Acenaphthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Acenapthylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Benzo (a) anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Benzo (a) pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Benzo (b) fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Benzo (g, h) perylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Benzo (k) fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Chrysene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Dibenzo (a,h) anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Fluorene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Indenol (1,2,3- c,d) pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Napthalene	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-
Phenanthrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Pesticides – organochlorine (µg/l)															
BHC alpha	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
BHC beta	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
BHC delta	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
BHC gamma (Lindane)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Chlordane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
DDD-p, p'	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
DDE-p, p'	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
DDT-p,p	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Endosulfan alpha	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Endosulfan beta	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Endosulfan sulphate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Endrin	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Endrin aldehyde	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Methoxychor	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Heptachlor	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	-
Aldrin	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	-
Dieldrin	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	-

Parameter (mg/L)	Khor Mor Gawra Spring	Taza Shaher-Spring	Shekh Hameed-Spring	SP2 (spring)	SP4 (spring0	GW5 (spring)	SP3 (duplicate of SP2)	Zhazh-Spring	Takhta Mina-Spring	Ibrahim Ghulam-Spring	Paryawla Well (groundwater)	WW2 (groundwater)	WW3 (groundwater)	WW6 (duplicate of WW3)	Project Standard
Heptachlor epoxide	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	-
Chlorpyrifos	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Dichlorvos	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Dimethoate	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Disulfoton	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Fenchlorphos	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Methyl parathion	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Parathion	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Phorate	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Famphur	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Guthion	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
o, o, o-triethylphosphorothionate	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Sulfotep	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Thionazin	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Tokuthion	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-
Ethoprophos	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-

Red - exceeds Project Standard

cfu/L - colony forming unit per litre

NTU - Nephelometric turbidity unit

µg/l - micrograms per litre

3.2.5 Noise

3.2.5.1 Area of influence - noise

The AOI for noise is summarised in Table 3-13.

Table 3-13 AOI - noise

Topic	Construction phase	Operations phase
Noise	500 m from the main site boundaries 250 m either side of the flowlines to reflect the use of mobile construction plant and machinery 250 m either side of the roads used for the transportation of construction materials and workers	1 km from the existing facility boundary to reflect noise generated from power generation and other equipment during routine operations 1 km radial distance from the flare to reflect noise generated during non-routine flaring events 250 m either side of the public road network to reflect the generation of noise from road movements

Within the AOI the nearest noise sensitive receptors in the vicinity of the proposed development are summarised in Table 3-14 below. Further details are provided in the following sections.

Table 3-14 Nearest noise sensitive receptors to the facility

ID	Receptor	Direction relative to Khor Mor existing facility
R1	Khor Mor Gawra	West
R2	Mamisik	East
R3	Khor Mor Bichuk	North-west
R4	Awaye Jalal	South
R5	Permanent camp	South-west

3.2.5.2 Past field data collection in the Project area

The ambient noise levels within the concession block were recorded as part of field studies undertaken in 2010 (MapCom, 2010). The noise level measurements were conducted using an Integrating and Logging Sound Level Meter (SLM), Quest, Model 2900 UL. Noise levels were measured for about 5 to 10 minutes at each location during daytime (Figure 3-5). Weather conditions were normal and there was no excess wind during the measurements. The results (see Table 3-15) show that ambient noise levels were below the Project Standard residential limits and were typical of rural areas with some domestic and commercial activities.

Table 3-15 Ambient noise levels (dB (A)) at Khor Mor (MapCom, 2010)

Location (see note)	L_{eq}	L5	L10	L50	L90	Project Standard*
AQ1	35.5	30.5	30.0	30.0	30.0	50-60
AQ2	40.5	40.0	35.5	35.0	30.0	
AQ3	45.0	40.5	40.0	35.5	30.0	
AQ4	35.0	30.0	30.0	30.0	30.0	
AQ5	45.5	45.0	40.5	40.0	35.0	
AQ6	40.5	40.0	35.5	35.0	30.0	

dB(A) – decibel (A-weighted)

- for residential land use

Note: noise monitoring conducted at same locations as air quality

Red – exceeds Project Standard

3.2.5.3 Current field data collection in the Project area

A baseline noise survey was undertaken by RSK at several locations to establish the existing noise climate at the surrounding receptor locations and in the vicinity of the existing facility. Sample locations are presented in Figure 3-4. The survey was undertaken in August 2019 and comprised unattended measurements taken over a 24-hour period at 10 positions and short-term attended daytime monitoring around the boundary of the existing facility (12 positions). Measurements were undertaken through 15 integration periods.

Sound level meters used for the baseline survey complied with the Class 1 requirements defined by International Electrotechnical Commission 61672-1:2013 and British Standard EN 61672-1:2013 *'Electroacoustics - Sound Level Meters – Part 1: Specifications'*.

The meters have calibration certificates from a traceable laboratory, which demonstrate that calibration was undertaken within one month of the date of survey. The calibration of the meters was field checked before and after measurements with a suitable calibrator which validated that the meters were within acceptable measurable limits. The calibrator used conformed to the requirements of BS EN IEC 60942:2018 *Electroacoustics, Sound calibrators*. The sound level meters were setup on a tripod between 1.2 m and 1.5 m above local ground level, with the meters positioned a minimum of 3.5 m (free-field) from any vertical reflective surfaces (i.e. buildings, fences and walls etc.).

An overview of the baseline measurements is provided in Table 3-16. As shown, average night-time residential noise levels (L_{eq}) exceeded the Project Standard (Appendix 3, Table A3.4 and A3.5), at one location (M14) although episodic loud noise events resulted in maximum readings (attributed to vehicular movements during the monitoring period). The day-time industrial Project Standard was also exceeded at two industrial locations (M2 and M3).

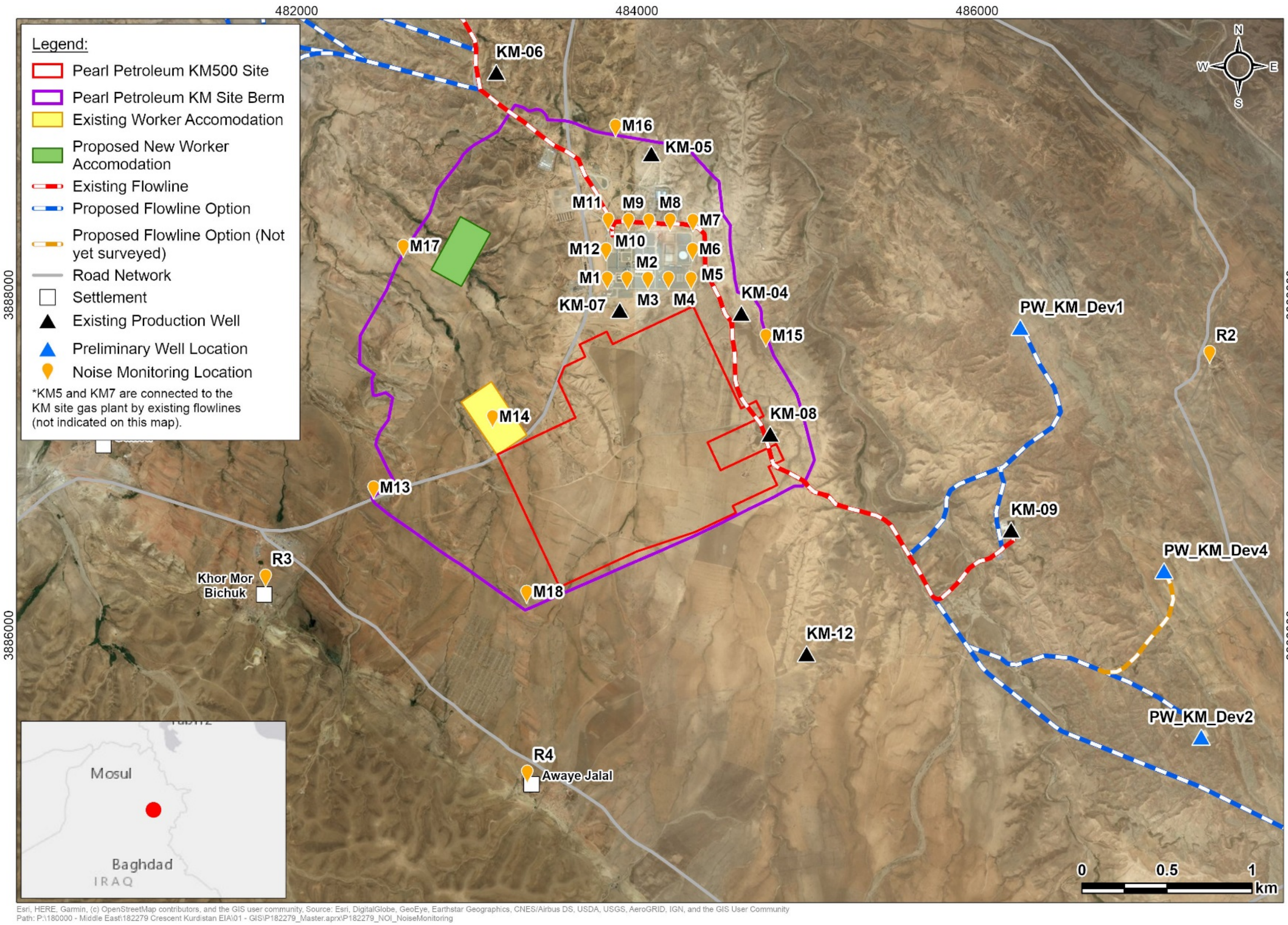


Figure 3-4 Noise monitoring locations (RSK, 2019)

Table 3-16 Current noise survey results in 2019

Ref.	Survey location	Period	Measurement data (dB)				Project Standard
			L_{Aeq}	L_{AFmax}	L_{A90}	L_{A10}	
R1	Khor Mor Gawra (residential)	18:00-22:00	43	46-68	39	44	45-55
		22:00-07:00	50	42-67	35	45	40-50
		07:00-18:00	39	46-68	30	41	50-60
R2	Mamisik (residential)	09:30-22:00	36	36-66	28	36	45-55
		22:00-07:00	40	29-83	27	35	40-50
		07:00-09:30	38	52-66	21	34	50-60
R3	Khor Mor Bichuk (residential)	15:05-22:00	42	50-70	31	45	45-55
		22:00-07:00	41	45-75	34	42	40-50
		07:00-15:05	44	45-74	36	46	50-60
R4	Awaye Jalal (residential)	16:15-22:00	48	48-77	32	42	45-55
		22:00-07:00	43	44-67	38	44	40-50
		07:00-16:15	47	52-73	38	49	50-60
M1	Measurements adjacent to boundary of existing facility (industrial)	10:57-11:12	66	69	64	67	60-70
M2		15:50-16:05	74	79	73	75	60-70
M3		16:08-16:23	76	78	75	77	60-70
M4		16:46-17:01	62	71	60	64	60-70
M5		14:28-14:43	59	68	56	61	60-70
M6		14:02-14:17	56	63	54	58	60-70
M7		13:10-13:25	69	81	60	73	60-70
M8		12:48-13:03	69	73	68	70	60-70
M9		12:29-12:44	68	77	66	71	60-70
M10		12:07-12:22	64	67	62	65	60-70
M11		11:42-11:58	54	59	51	57	60-70
M12		11:19-11:34	63	67	62	64	60-70
M13	Western boundary of existing facility (industrial)	19:00-22:00	43	46-51	39	45	55-65
		22:00-07:00	52	35-80	38	46	50-60
		07:00-19:00	48	43-87	30	41	60-70*
M14	Permanent camp (residential)	18:00-22:00	47	47-56	42	47	45-55
		22:00-07:00	51	51-62	47	52	40-50
		07:00-18:00	53	45-85	40	47	50-60
M15	Eastern boundary of existing facility (industrial)	17:20-22:00	51	51-81	47	52	55-65
		22:00-07:00	51	48-87	46	51	50-60
		07:00-17:20	50	45-86	43	49	60-70
M16		06:30-07:00	49	58-68	47	50	50-60

Ref.	Survey location	Period	Measurement data (dB)				Project Standard
			L_{Aeq}	L_{AFmax}	L_{A90}	L_{A10}	
	Existing facility access road (industrial)	07:00-22:00	51	48-90	41	48	60-70*
		22:00-06:30	51	49-98	45	48	50-60
M17	Northern boundary of existing facility (industrial)	05:55-07:00	39	45-62	35	41	50-60
		07:00-22:00	41	41-70	30	40	60-70*
		22:00-05:55	44	40-73	38	45	50-60
M18	Southern boundary of existing facility (industrial)	10:00-22:00	40	40-78	31	38	60-70*
		22:00-07:00	40	34-73	33	38	50-60
		07:00-10:00	46	35-78	30	37	60-70

dB(A) – A-weighted decibel (as perceived by human ear)

L_{A10} noise level exceeded for 10% of the measurement period (A-weighted)

L_{A90} noise level exceeded for 90% of the measurement period (A-weighted)

L_{Aeq} equivalent continuous sound pressure level (A-weighted)

L_{Amax} maximum value sound pressure level reached during a measurement period (A-weighted)

Note: Reported L_{Aeq} values are logarithmic averages of 15 minutes integration periods, L_{A90} and L_{A10} indices are reported as arithmetic mean values.

Red - exceeds Project Standard

- lowest Project Standard selected when monitoring conducted over two time periods

3.2.6 Air quality

3.2.6.1 Area of influence - air quality

Based on proposed activities during construction and operations and sensitive receptors, the AOI for noise has been defined as shown in Table 3-17.

Table 3-17 AOI - air quality

Topic	Construction phase	Operations phase
Air Quality	250 m from the main site, well sites and either side of the flowlines to reflect the use of mobile construction plant and machinery 150 m either side of the roads used for the transportation of construction materials and workers to reflect the generation of dust and air emissions	1 km from the flare (pilot flame) during routine operations to reflect the dispersion of air emissions to background levels 10 km from flare during non-routine events (such as an emergency blowdown) to reflect the dispersion of air emissions to background levels 150 m either side of the public road network to reflect the generation of noise from road movements

3.2.6.2 *Description of Project area air quality*

Air quality degradation has been observed in various regions in Iraq, including Kurdistan. primarily due to industrial and petroleum operations.

Degradation of ambient air quality specific to Kurdistan stems mainly from increasing vehicle numbers in the region generally, as well as increasing cement production and increases of oil refining capacity (Hamid *et al*, 2013).

Further sources of air pollution in Kurdistan include the following:

- emissions from industrial facilities including power plants, petroleum refineries, chemical production, brick kilns, and lead and aluminium smelters
- open burning of waste resulting from a lack of waste management facilities
- increase in illegal logging for fuel use.

Increasing frequency and severity of dust and sandstorms resulting from soil disintegration and erosion, deterioration of vegetation, desertification, and deterioration of green spaces has led to increased particulate emissions to the atmosphere (World Bank, 2017).

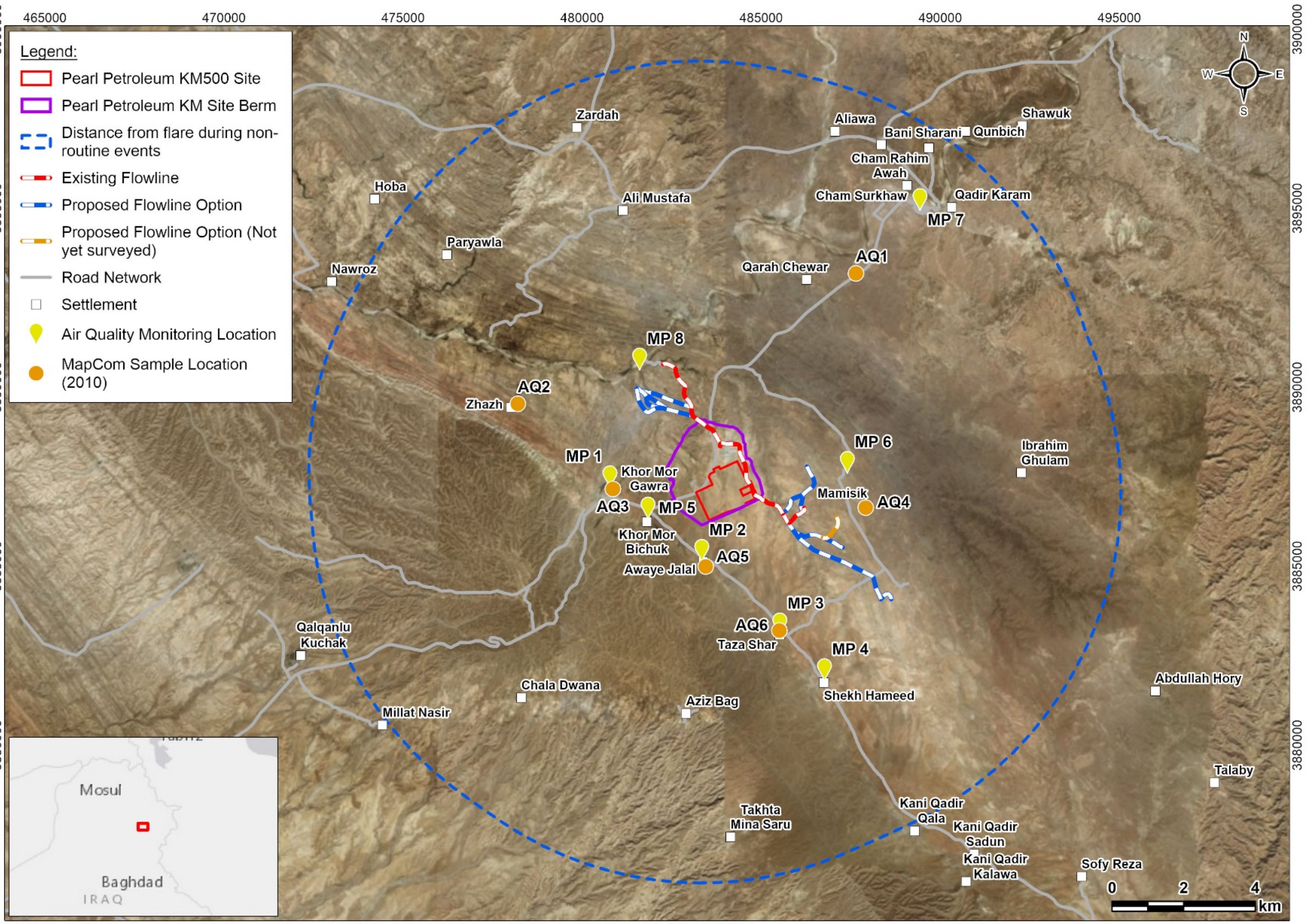
Air quality in the Khor Mor area and the region could likely be affected by emissions from industries, traffic and power generation in the area. Previous studies conducted in the Project area indicate ambient concentrations of sulphur oxides (SO_X) and particulate matter (PM_{10} particles smaller than 10 microns) to be above Project Standards.

3.2.6.3 *Past field data collection in the Project area*

An environmental baseline survey for the Liquified Petroleum Gas Development, Khor Mor Gas Field Project was conducted by MapCom Environmental Consultants in 2010. The field survey found no major industrial or commercial activities within the concession area. The area was found to vary from a residential to rural setting with ambient air quality expected to represent the general area type.

As part of the survey, passive diffusion tubes were deployed (for a three-week period) at six locations in the Khor Mor area to measure atmospheric concentrations of sulphur dioxide (SO_2), nitrogen oxides (NO_X) and ozone (O_3) (see Figure 3-5).

As shown in Table 3-18, in the 2010 survey, exceedance of the annual average limits were reported for SO_2 and NO_2 concentrations. No other exceedances of the KRI air quality guideline values were recorded. MapCom reported drilled oil wells and oil seeps located south of the site in the vicinity of these sampling locations.



Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community. Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Figure 3-5 Ambient air quality monitoring locations

Table 3-18 Ambient air quality results (MapCom, 2010)

Location	Location	Concentration (µg/m3)		
		SO_2	NO_2	O_3
Qarah Chewar	AQ1	45.63	45.63	85.97
Zhazh	AQ2	59.51	59.51	112.05
Khor Mor	AQ3	61.18	61.18	119.53
Mamisik	AQ4	138.32	98.32	95.05
Shekh Jalal	AQ5	93.76	83.76	76.14
Taza Shar	AQ6	95.19	75.19	64.87
KM250A Project Standard (unless otherwise stated)		20*	40	100 (8 hour)**

µg/m^3 – micrograms per cubic metre

Red – exceeds Project Standard

* - Annual (lower number in range for SO_2)

* Air quality guideline value, as per IFC General Environmental Health and Safety Standards (2007) referencing WHO (2005) Ambient Air Quality Guidelines (125 µg/m^3 is the interim target value). Note: diffusion tube measurement (which usually occurs over a period of a week to a month) normally cannot be directly compared to the 8-hour limit, but an annual standard does not exist for O_3.

MapCom (2010) also included measurement of dust levels at the above locations using a direct reading particulate matter (PM) monitor. Measured dust concentrations were found to vary from 61 µg/m^3 near the settlements, to 127 µg/m^3 at location AQ3 (Khor Mor), adjacent to asphalt roads. These exceeded the Project annual standard for PM_{10} of 20 µg/m^3.

Ground level O_3 exceeded the Project Standard in Zhazh and Khor Mor village. Ozone is formed in the atmosphere by photochemical reactions in the presence of sunlight and precursor pollutants, such as NO_x and volatile organic compounds (VOCs). Ozone precursors can come from car exhaust.

VOC monitoring at residential areas was undertaken using solid adsorption/solvent extraction and gas chromatograph/mass spectrometer. The results of the VOC monitoring are summarized in Table 3-19. Benzene concentrations in ambient air were reported to be above the Project annual standard of 0.003 milligrams per cubic metre (mg/m^3, 0.94 part per billion, ppb).

Table 3-19 Ambient air quality results for VOCs (MapCom, 2010)

SI No	Pollutant	Concentration (ppb)	KM250A Project Standard (ppb)
1	1,1 dichloroethane	6.22	None
2	Benzene	3.13	0.94
3	C-1,3-dichloropropene	4.08	None
4	Toluene	5.85	None
5	Xylene	3.44	None

SI No	Pollutant	Concentration (ppb)	KM250A Project Standard (ppb)
6	P-dichlorobenzene	8.19	None
7	Ethyl benzene	0.80	None
8	Styrene	1.47	None
9	Bromobenzene	4.65	None
10	1,3,5-trimethylbenzene	2.27	None
11	1,2,4-triethylbenzene	2.16	None
12	N-butyl benzene	5.0	None
13	Naphthalene	4.57	None
14	p-Isopropyletoluene	5.18	None
15	1,2,4 trichlorobenzene	5.4	None

Red – exceeds Project Standard

Ambient air quality data for Khor Mor was collected by ERM (2015) as part of an EIA study for the Khor Mor Gas Project. The survey included ambient air quality data collection from within the Project study area as well as three other locations for a 24-hour period. The results are presented in Table 3-20 and show that ambient concentrations of SO_x and PM_{10} exceeded Project Standards. Dust levels were found to approach the first target level indicating the ambient dust levels are elevated but may be expected on a windy day at the end of a dry summer.

Table 3-20 Ambient air quality results (ERM, 2015)

Pollutant	Results (µg/m3)	Project Standard 24-hour (µg/m3)
SO_X	25	20
NO_2	21	94
Carbon monoxide (CO)	155	11456*
PM_{10}	95	50
VOCs	0.30	765**

Red – exceeds Project Standard

* As there is no 24-hour standard prescribed for CO, the results have been compared to the 8-hour averaging period limit.
** As there is no 24-hour standard prescribed for VOC, the results have been compared to the 3-hour standard. For conversion average molecular weight has been assumed to be 78 g/mol

In 2018, MapCom conducted an air quality survey for SO_2, NO_2, VOC, CO, O_3, PM_{10} and $PM_{2.5}$ (particles smaller than 2.5 microns) at 11 locations (Table 3-21). The results have been compared to the annual average limits in the Project Standards. Concentrations of SO_2, CO and O_3 were not detected or did not exceed the Project Standard at any location. For NO_2 concentrations, a minor exceedance is reported at location 10. VOC concentrations exceeded the Project Standard at location 2 and 5 and exceedances were reported at all locations for PM_{10} and $PM_{2.5}$.

Table 3-21 Ambient air quality results (MapCom, 2018)

ID	Location	Easting	Northing	SO_2 (ppm)	NO_2 (ppm)	VOC (ppm)	CO (ppm)	O_3 (ppm)	PM_{10} (mg/m3)	$PM_{2.5}$ (mg/m3)
1	KM-9, KM-10	486623	3881892	ND	ND	0.11	ND	0.008	35.6	6.7
2	KM-9, KM-10	486297	3881844	ND	ND	0.39	ND	ND	227	6.4
3	KM-10	489326	3877456	ND	ND	0.11	ND	ND	24	7
4	KM-10	490887	3880825	ND	ND	ND	ND	0.019	16.2	6.2
5	KM-9, KM-10	487104	3887603	ND	0.02	0.83	ND	0.009	16.1	6.9
6	KM-9	485382	3882900	ND	ND	ND	ND	ND	24.5	7.2
7	KM-9	485609	3883101	ND	ND	ND	ND	0.002	31	9
8	KM9, KM12	485004	3885899	ND	ND	0.16	ND	ND	30.5	7.1
9	KM-9	487311	3885416	ND	ND	0.01	ND	ND	26.2	6.8
10	KM-10	483519	3885186	0.01	0.04	0.09	ND	0.07	29.4	7.75
11	KM-9, KM-10	489017	3882232	ND	ND	NA	NA	NA	21.8	6.4
Project Standard (annual average unless otherwise stated)				0.018	0.02	0.24*	9.1	100	0.02 (20µg/m^3)*	0.01 (10µg/m^3)*

ppm – parts per million

ND – not detected

NA – not analysed

Red – exceeds Project Standard

* As there is no 24-hour standard prescribed for VOC, the results have been compared to the 3-hour standard

3.2.6.4 *Current field data collection in the Project area*

A baseline air quality monitoring survey for the KM250A Project was undertaken in August 2019 at eight sampling locations (Figure 3-5) within the Project AOI (Table 3-17) by RSK. The survey was undertaken at the following locations:

- Khor Mor Gawra village (MP1)
- Awaye Jalal village (MP2)
- Taza Shah village (MP3)
- Shekh Hameed village (MP4)
- Khor Mor Bichuk village (MP5)
- Mamisik village (MP6)
- Qadir Karim village (MP7)
- Key location outside of villages (MP8).

Baseline air quality conditions at each of the eight sites was characterised in order to effectively assess the potential impacts of the proposed development. Diffusion tubes were deployed to measure concentrations of NO_2, SO_2, hydrogen sulphide (H_2S), PM_{10}, CO, O_3 and VOCs including benzene. The diffusion tubes were analysed after exposure (approximately 30 days) by Gradko International, based in the UK. A field blank was also analysed.

A comparison of the air quality monitoring results with the Project Standards indicate the measured pollutants are largely within the limits (Table 3-22).

The Project Standard for SO_2 concentrations (20 μg/m^3) was exceeded at:

- Jalal village (MP2) (23.54 μg/m^3)
- Taza Shah village (MP3) (21.87 μg/m^3)
- Khor Mor Bichuk village (MP5) (25.25 μg/m^3).

The Project Standard for O_3 concentrations (100 μg/m^3) was exceeded at:

- Jalal village (MP2) (106.61 μg/m^3)
- Taza Shah village (MP3) (118.27 μg/m^3)
- Mamisik village (MP6) (125.42 μg/m^3)
- Key location outside of villages (MP8) (119.23 μg/m^3).

Table 3-22 Current air quality monitoring results in 2019

Parameter	Unit	Khor Mor Gawra	Awaye Jalal	Taza Shar	Shekh Hameed	Khor Mor Bichuk	Mamisik	Qadir Karim	Other location	KM250A Project Standard (annual)
		MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	
SO_2	µg/m³	11.66	23.54	21.87	18.64	25.25	12.92	15.69	15.37	20 – 47
NO_X	µg/m³	2.5	2.2	1.4	2.4	2.7	2.5	2.5	4.6	-
NO_2	µg/m³	2.5	2.2	1.4	2.4	2.7	2.5	2.5	4.6	40
H_2S	µg/m³	0.08	0.04	<0.01	0.01	<0.01	<0.01	0.03	<0.01	-
O_3	µg/m³	68.1	106.61	118.27	79.55	99.9	125.42	85.54	119.23	100
Benzene	µg/m³	0.5	0.5	0.5	0.6	0.5	0.6	<0.5	0.7	3
Toluene	µg/m³	0.5	<0.4	<0.4	0.5	<0.4	1	<0.4	0.9	-
Ethylbenzene	µg/m³	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	-
m/p-xylene	µg/m³	<0.3	<0.3	<0.3	0.3	<0.3	0.7	<0.3	0.5	-
o-xylene	µg/m³	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	-
Top 5 VOC	µg/m³	83	111.1	127.3	95.3	97.9	81.8	68.2	85.7	-
Total VOC (C6 - C16)	µg/m³	74.4	114	133	120	117	113	73.6	101	-
CO	ppm	0	0	0	0	0	0	0	0	9 – 10 (8-hour)
$PM_{2.5}$	µg/m³	0.007	0.006	0.009	0.009	0.009	0.007	0.011	0.011	10
PM_{10}	µg/m³	0.024	0.01	0.014	0.016	0.019	0.014	0.026	0.02	50

Red – exceeds Project Standard

3.3 Biological environment

3.3.1 Area of influence - biodiversity

The AOI for biodiversity is shown in Table 3-23 and Figure 3-6. The literature review covered the whole 10 km AOI, however, the survey area focused just on the Project Development Area and a 50 m buffer to identify species and habitats that may be affected by indirect impacts.

Table 3-23 AOI - biodiversity

Topic	Construction phase	Operations phase
Biodiversity	The physical footprint of the Project plus a 50 m buffer, to reflect the removal of vegetation and loss of ecological receptors within the main site and along the flowlines. 2 km from site boundary and flowlines to reflect the use of artificial lights.	2 km from the site boundary to reflect the use of artificial lights. 1 km radial distance from the flare to reflect noise generated during non-routine flaring events (as above). 2 km radial distance from the flare (pilot flame) to reflect the change in visual setting during routine operations that may affect biodiversity. 10 km from flare during non-routine events (such as an emergency blowdown), as an approximate distance from where the flare is expected to be visible.

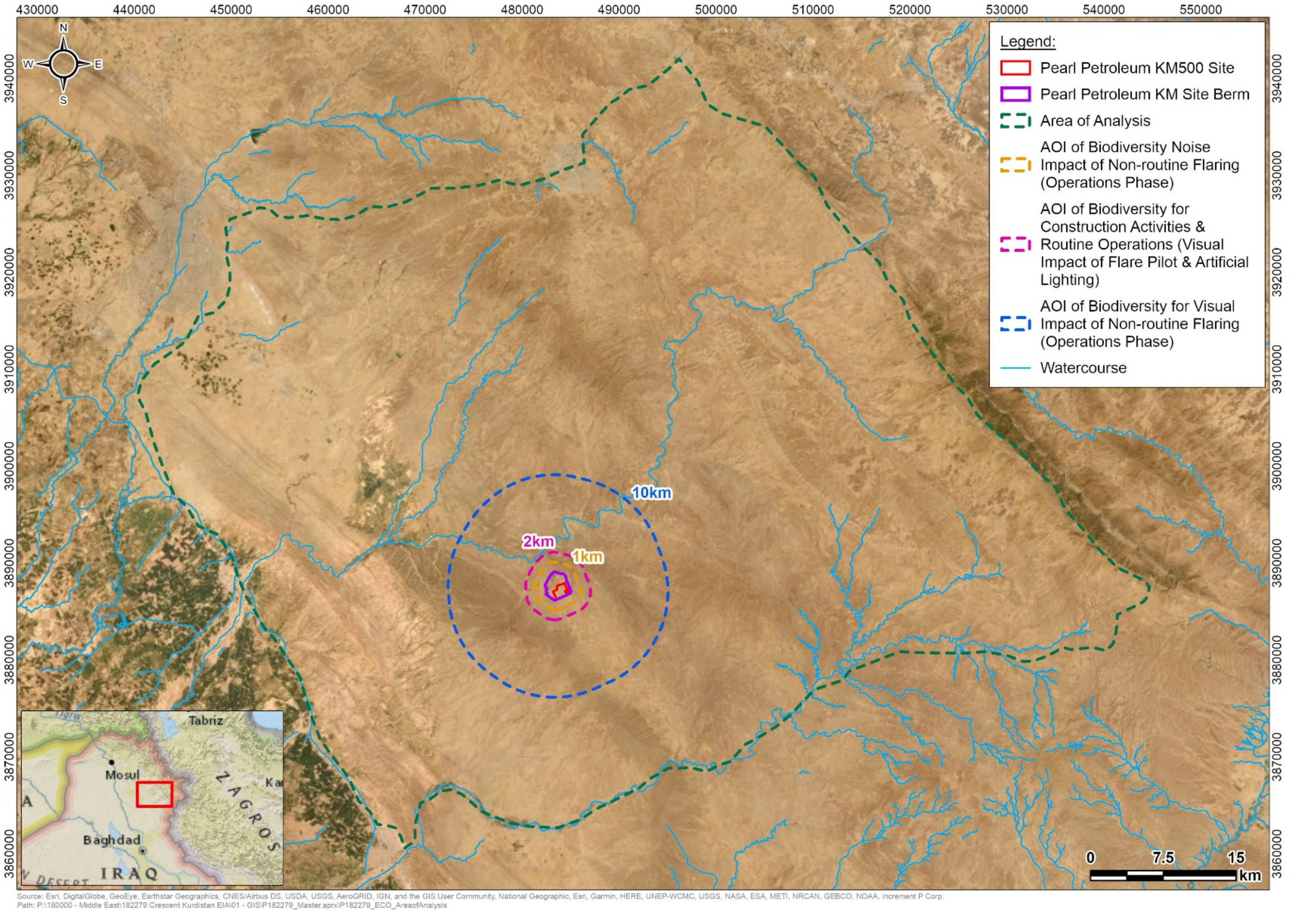

Figure 3-6 AOA and AOI - biodiversity

3.3.2 Past field data collection in the Project area

Secondary data were used to characterise the biodiversity of the Project area, provide context to the information returned from the biodiversity field surveys and to identify potential critical habitat qualifying features. Secondary data sources in the Project area included:

- previous surveys undertaken by others:
  - Nature Iraq (2008 and 2017) Key Biodiversity Surveys of Kurdistan, Northern Iraq
  - Ararat (2009) Key Biodiversity Areas: Rapid Assessment of Birds in Kurdistan, Northern Iraq
- Integrated Biodiversity Tool for Business
- Protected Planet
- World Wildlife Fund Global Ecoregions
- Nature Conservancy Ecoregional Assessments
- Critical Ecosystem Partnership Fund Biodiversity Hotspots
- Wetlands International's Critical Site Network Tool
- International Union for the Conservation of Nature (IUCN) Red List of Threatened Species
- freely available satellite imagery and land cover classification
- previous environmental impact studies:
  - Worley Parsons (2007) Kurdistan Gas Project Environmental Impact Assessment Volume i: Gas Pipeline from Khormor to Erbil. Crescent Petroleum Dana Gas (CPDG)
  - ERM (2015) Khor Mor Gas Plant: Environmental Impact Assessment, CreDan
  - MapCom (2010) Environmental Baseline Study, Environmental Social Impact Assessment Report Khor Mor Block.

3.3.3 Current field data collection in the Project area

Nature Iraq, a Kurdish group, was commissioned by RSK to undertake a biodiversity baseline survey between 26 September and 1 October 2019. The Nature Iraq surveyors were supported by experienced ecologists from RSK. The primary objective of the surveys was to identify the priority biodiversity values for the Project. The study area for the field survey comprised the Project footprint and a 50 m buffer area surrounding the fenceline and along the flowlines. The survey locations within this study area are presented in Figure 3-7. These biodiversity baseline surveys are discussed below in more detail.

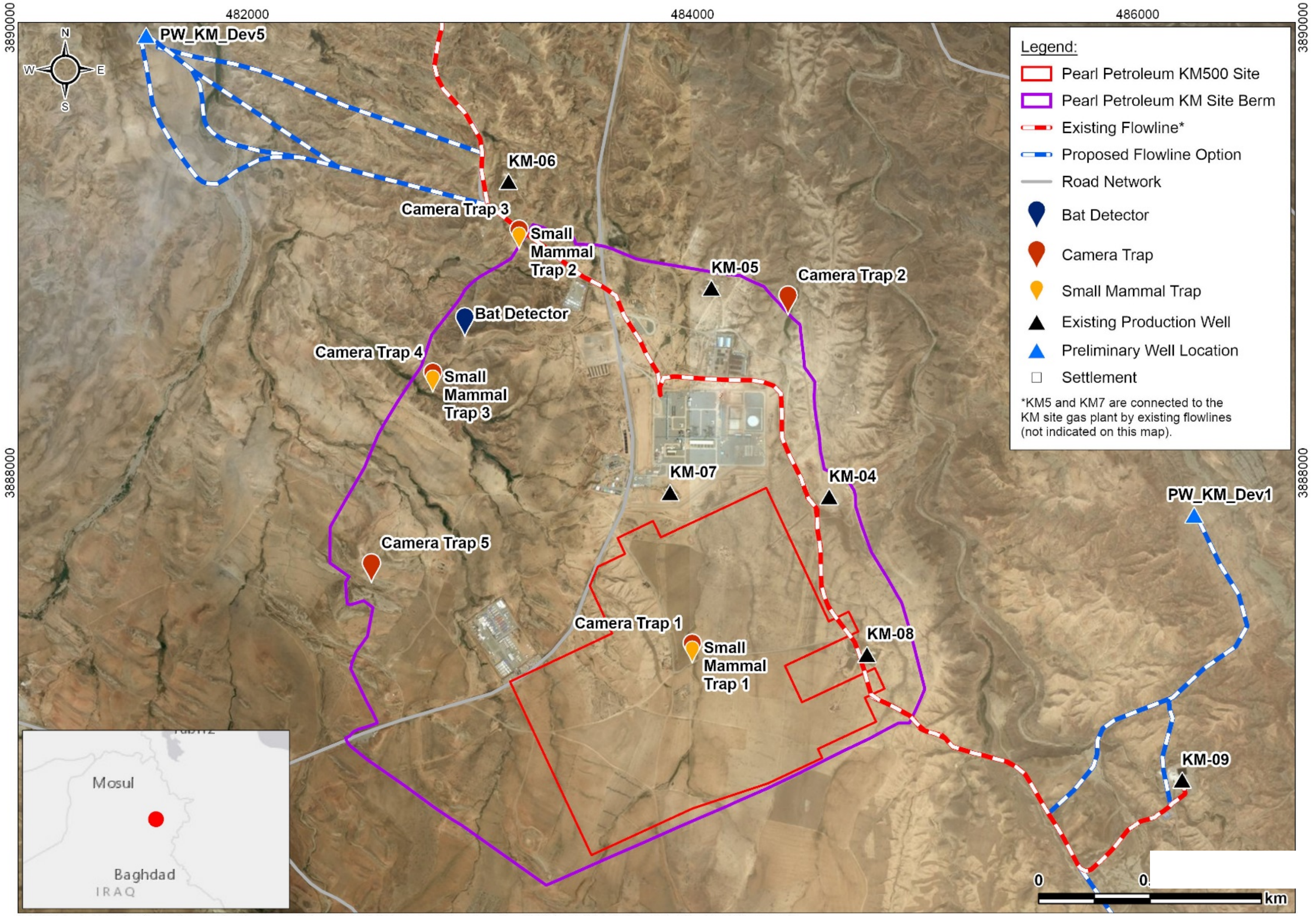

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Figure 3-7 Biodiversity baseline survey locations

3.3.3.1 *Habitats and flora*

A rapid walkover habitat and botany survey was undertaken between 28 September and 2 October 2019 by Nature Iraq. The dominant habitat types located within the study area were identified and their floristic composition was characterised by a botanical specialist. The survey confirmed the presence/likely absence of any rare or threatened habitats of conservation importance within the study area.

The survey also confirmed the presence/likely absence of any vascular plant species of conservation importance. In the context of this baseline assessment, vascular plants of conservation importance are defined as nationally and/or globally rare or threatened species, and endemic and/or restricted range species. Focus was given to species that may trigger critical habitat in accordance with PS6 (IFC, 2012).

Habitat mapping was undertaken using visual interpretation of satellite imagery, supplemented by existing baseline data and ground-truthing conducted during the surveys. Satellite imagery used for habitat mapping was based on Vivid Digital Globe aerial imagery (2015). The mapping was further validated and refined based on the findings of the field surveys to include any priority habitats that were not previously identified.

Habitats were further categorised into modified and natural habitats in accordance with IFC PS6 criteria (IFC, 2012) which defines these as follows:

- Natural habitats are areas composed of viable assemblages of plant and or animal species of largely native origin, and or where human activity has not essentially modified an area's primary ecological functions and species composition.
- Modified habitats are areas of land that support a large proportion of flora and or fauna species that are non-native in origin, and or where human activity has substantially modified an area's primary ecological functions and species composition.

Areas composed of shrubland habitat were considered to be transitional habitat[5]. These areas are included as modified habitats.

3.3.3.2 *Walkover priority fauna survey*

A walkover priority fauna survey of the study area was undertaken between 28 September and 2 October 2019 by a fauna specialist. The primary objective of the survey was to increase the current level of understanding regarding the presence/likely absence of priority fauna species' habitat usage in the study area including mammals, reptiles, amphibians and invertebrates. Priority fauna of conservation importance are defined as nationally and/or globally rare or threatened species, and endemic and/or restricted range species and congregatory species present in significant numbers. Surveyors searched for direct evidence (i.e. sightings, vocalisations) and indirect evidence of fauna activity (i.e. prints, scats, feeding remains, scents-urine). Surveyors used binoculars to maximise their field of vision.

[5] Transitional habitats are habitats in the process of becoming modified but that have the potential for restoration, and which may support important ecosystem functions and connectivity.

If evidence of a priority fauna or flora species was observed, the following parameters were recorded:

- species
- location
- type of observation: direct evidence (i.e. sighting, call) and indirect evidence (e.g. faeces, prints, feeding remains, nests, burrows etc.)
- number of observations
- surrounding habitat type
- photographs taken where possible.

3.3.3.3 *Small mammal trapping*

Small mammal traps were deployed over the five-day field survey. The traps were baited with nuts and meat to entice small mammals and reptiles, and positioned in suitable habitat for reptiles and small mammals (scrub and long grass) in locations shown in Table 3-24 and Figure 3-7. The traps were checked early each morning and set again in the late afternoon to ensure that animals are not trapped for long periods of time without food or water. Species were photographed and identified before being released.

Table 3-24 Locations of small mammal traps

Equipment	Northing	Easting
Small mammal trap 1	35.127052°	44.824369°
Small mammal trap 2	35.143803°	44.815793°
Small mammal trap 3	35.138005°	44.811548°

3.3.3.4 *Camera trapping*

Five high-definition infrared camera traps were strategically installed in a range of habitat types of likely occurrence for priority fauna (i.e. in habitats where indirect evidence was previously identified, near wildlife trails, potential watering points, etc.) based on prior knowledge of the target species' ecology and movement patterns. This aimed to increase the likelihood of detecting priority species. Habitat condition is one factor that may affect the movement of mammals throughout the study area, hence where possible, camera traps were not placed amongst highly disturbed habitats. The cameras were left *in-situ* at locations shown in Table 3-25 and Figure 3-7 for a period of up to 21 days. The camera traps were collected, and the photographic data were then analysed.

Table 3-25 Locations of camera traps

Equipment	Northing	Easting
Camera trap 1	35.127052°	44.824369°
Camera trap 2	35.141154°	44.829062°
Camera trap 3	35.143803°	44.815793°
Camera trap 4	35.138005°	44.811548°
Camera trap 5	35.130278°	44.808541°

3.3.3.5 *Birds*

A bird survey was undertaken between 28 September and 2 October 2019 by an ornithologist. The survey began between one or two hours after sunrise to coincide with peak bird activity. All bird species that were sighted or heard vocalising were recorded on field maps along with notes of behavior. Binoculars and a scope were used to increase the surveyor's field of vision. Focus was given to priority bird species of conservation importance namely: nationally and/or globally rare or threatened species, endemic and/or restricted range species, and congregatory and migratory bird species present in significant numbers.

3.3.3.6 *Bats*

A Song Meter 4 (SM4) detector was placed close to aquatic habitat considered suitable for foraging bats (Latitude N 35.138005° Longitude E 44.811548°) and set to record for a period of two nights. The detector commenced recording 15 minutes before sunset and ceased recording 15 minutes after sunrise. The bat calls obtained from the static bat detector surveys were analysed using appropriate sound analysis software.

The data was analysed to:

- characterise the habitat usage of the study area by priority bats species (i.e. nationally and/or globally rare or threatened species, endemic/restricted range species and congregatory species)
- assess species composition in the study area
- gauge the presence of a significant number of roosting bats.

3.3.4 Critical habitat assessment

RSK conducted a critical habitat assessment (CHA) (RSK, 2020) which provided a technical assessment of the extent of natural and critical habitats of relevance to the proposed KM250A Project. Natural and critical habitats are areas of high biodiversity value, where stringent requirements must be met if Project activities are to be permitted within them. An impact assessment on the qualifying species was subsequently conducted (which did not identify any significant impacts to any qualifying species or habitat).

Critical habitats are areas with high biodiversity value determined on the basis of meeting one or more of the following criteria defined by IFC (2012):

- Criterion 1: habitats of significant importance to critically endangered (CR) and/or endangered (EN) species
- Criterion 2: habitat of significant importance to endemic and/or restricted-range species
- Criterion 3: habitat supporting globally important concentrations of migratory and/or congregatory species
- Criterion 4: highly threatened and/or unique ecosystems
- Criterion 5: areas associated with key evolutionary processes.

The fulfilment of any one of these criteria is enough to qualify habitat as critical. Critical habitats can be either natural habitats or modified. The presence of critical habitat does not necessarily mean that the project will impact particular critical habitat-qualifying features. A number of scenarios are possible, from impacts that are negligible, readily avoided or temporary, to those that are significant, long-term and challenging to mitigate.

However, being within critical habitat does mean that the project developer needs to pay special attention to the management of biodiversity impacts.

3.3.4.1 *Methodology*

The determination of critical habitat is initially undertaken in isolation of any proposed project activities. The following steps were followed in assessing candidate species against Criteria 1 to 3:

1. define the overall ecologically appropriate area of analysis (AOA)
2. prepare a list of candidate species to include in the assessment
3. obtain or calculate the global extent of occurrence[6] (EOO), area of occupancy[7] (AOO), population size and/or number of known sites for candidate species
4. obtain or calculate:
    a. the EOO, AOO, population size and/or number of known sites of each candidate species within the area of analysis
    b. for CR, EN and vulnerable (VU) species that are wide-ranging and/or whose population distribution is not well understood, an assessment of the importance of the broader landscape was made based on literature review and professional judgement
5. calculate the proportion of the global or national EOO, AOO and/or population represented by these results
6. screen outputs against significance thresholds.

The AOA was determined using interpretation of aerial imagery to select an appropriate area of homogenous habitat type and supporting similar species, as shown in Figure 3-6. The KM250A Project is located in moist steppe habitat in undulating terrain. This habitat type extends out to the mountain range to the east and a similar ridge to the west. The northern extent of the AOA includes a network of roads and settlements that are likely to form a barrier to movement to most species. The southern boundary is represented by the Awa Spi river running west to east which appears to delineate a flatter habitat area comprising lower lying wetland type habitats and small river valleys which is likely to support a different range of species than the KM250A Project AOA. The AOA is approximately 4,785 km^2 in area. The AOA is used as the basis for a landscape-based approach to assess potential biodiversity risks so encompasses a much larger area than the AOI for the KM250A Project construction phase, also shown in Figure 3-6.

For the Criterion 4 method, the IUCN is developing a Red List of Ecosystems (IUCN-CEM, 2016; IFC, 2019), following a similar approach to the IUCN Red List of Threatened Species (2019). Where formal IUCN assessments of ecosystems have been undertaken, these should be used to assess habitats for Criterion 4. Where no formal IUCN assessments have been undertaken, habitats may trigger Criterion 4 if they are determined to be of high priority for conservation by regional or national systematic conservation planning.

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[6] EOO is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a species, excluding cases of vagrancy This measure may exclude discontinuities or disjunctions within the overall distributions of taxa e.g. large areas of obviously unsuitable habitat (IUCN, 2001).

[7] AOO is defined as the area within a species extent of occurrence which is occupied by that species, excluding cases of vagrancy. This measure reflects the fact that a species will not usually occur throughout the full area of its EOO, which may contain unsuitable or unoccupied habitats (IUCN, 2001).

For the Criterion 5 method, the structural attributes of a region, such as its topography, geology, soil, temperature and vegetation, and combinations of these variables, can influence the evolutionary processes that give rise to regional configurations of species and ecological properties (IFC, 2019). This criterion will typically be triggered in areas that have been previously investigated and that are already known or suspected to be associated with unique evolutionary processes. It is further noted that while systematic methods to measure and prioritise evolutionary processes in a landscape do exist, they are typically beyond a reasonable expectation of studies conducted by the private sector.

3.3.4.2 Critical Habitat Assessment findings

Table 3-26 summarises the Critical Habitat Assessment (RSK, 2020) key findings. Consultation with various experts (Nature Iraq, University of Sulaymaniyah and Polytechnic University of Sulaymaniyah) was undertaken to refine the findings of the Critical Habitat Assessment. Implications of Project activities on potential critical habitat triggers are discussed in Section 5.7.5.5

Table 3-26 Summary of findings of the CHA

IFC PS6 criteria	IFC PS6 criterion threshold numbers	Critical habitat-qualifying features	
Habitats of significant importance to endangered or critically endangered species	1a	Euphrates softshell turtle (*Rafetus euphraticus*)	reptile
	1b	No critical habitat-qualifying features	
	1c	Euphrates softshell turtle (*Rafetus euphraticus*)	reptile
		steppe eagle (*Aquila nipalensis*)	bird
Habitats of significant importance to endemic or geographically restricted species	2	*Thymus neurophyllus*	plant
		yellowfin barbel *(Luciobarbus xanthopterus)*	fish
		Siebenrock's Caspian turtle (*Mauremys capsica*)	reptile
		binni *(Mesopotamichthys sharpeyi)*	fish
Habitats supporting globally significant (concentrations of) migratory or congregatory species	3a	No critical habitat-qualifying features	
	3b	No critical habitat-qualifying features	
	4a	No critical habitat-qualifying features	

IFC PS6 criteria	IFC PS6 criterion threshold numbers	Critical habitat-qualifying features
Highly threatened or unique ecosystems	4b	No critical habitat-qualifying features
Areas associated with key evolutionary processes	not applicable	No critical habitat-qualifying features
Protected areas and internationally recognised areas of high biodiversity value	not applicable	No critical habitat-qualifying features

3.3.4.3 *Impact assessment on critical habitat qualifying species*

An impact assessment was conducted on the critical habitat qualifying species presented in Table 3-26 and the results are presented in the full CHA report (RSK, 2020). The impact assessment considered:

- species ecology
- habitat preference
- population and trends
- stake of knowledge
- species sensitivity.

The impact assessment did not identify significant impacts to the species presented in Table 3-26..

3.3.5 Biodiversity baseline conditions

3.3.5.1 *Eco-regions*

The Project is located in an area known as the Zagros Mountain Forest Steppe eco-region. Zagros Mountain Forest Steppe is one of the most divergent eco-regions for plant habitat as it is part of the Taurus-Zagros Mountain range, which has a unique geographical formation that occupies 7 % of the entire KRI (Ahmad et al., 2018).

The Zagros Mountain Forest Steppe eco-region is mainly populated by oak-dominant deciduous forests and pistachio-almond forest with a diverse population of steppe flora. The key known fauna of this eco-region includes brown bear (*Ursus arctos*), Asiatic black bear (*Ursus thibetanus*), eagles (*Aquila* sp), wild goats (*Capra aegragus*), sheep (*Ovis orientalis*), wolves (*Canis lupus*), leopards (*Panthera pardus*) and other wild cats (*Felis* sp). It should be noted that these species have not been recorded in the study area according to available information. Anthropogenic activities within the study area (i.e. cultivation and overgrazing) has resulted in extensive natural habitat loss in the region.

3.3.5.2 *Designated or protected areas*

The Project area is not located within any nationally or internationally designated protected areas for biodiversity. The closest designated area for biodiversity to the Project area is the Chemchemal Key Biodiversity Area (KBA) and Important Bird Area (IBA) which are located approximately 12 km south-west of the Project area (Figure 3-8; site #IQ035, Sulaimani-35.421389°N 44.618333°E). KBAs are sites that contribute significantly to the global persistence of biodiversity, in terrestrial, freshwater and marine ecosystems and IBAs are places of international significance for the conservation of birds and other biodiversity (Birdlife International, 2019a).

Chemchemal KBA and IBA is located in the Moist Steppe Zone. The site is known to support the Eastern imperial eagle (*Aquila heliacal*) during the winter months which is categorised as Vulnerable by the IUCN Red List of Threatened Species (2019). The KBA/IBA also supports breeding populations of two Mediterranean, three Irano-Turanian and three Sahara-Sindian Desert biome-restricted bird species (Birdlife International, 2019b). Other fauna species of conservation importance that have been recorded in the KBA/IBA include the goitered gazelle (*Gazella subgutturosa*) which is categorised by IUCN (2019) as VU at the global scale and CR in the Mediterranean. This KBA/IBA has been adversely impacted by habitat loss and degradation arising from urban development, grazing and poor urban waste management.

Figure 3-8 Photograph of Chemchemal KBA and IBA (Nature Iraq, 2017)

3.3.5.3 *Habitats*

Nature Iraq (2019) has identified the following zones of plant communities in Kurdistan:

- dry steppe zones (recorded in Kalar and Fishkhaboor-Syrian Border)
- moist steppe zone (recorded in Dukan, Atrush Sangaw)
- forest zones - primarily *Quercus sp* forests however, pine forest is restricted to the Amadiya district of Dohuk in Zawita.

A habitat map providing an overview of the habitats within the AOI and surrounding area is presented as Figure 3-9 and photographs are shown in Figure 3-10 to Figure 3-12. The area is located within the moist steppe zone in Kurdistan (Guest, 1966). The majority of the habitats located within the survey area are categorised as modified habitats. These modified habitats include agro-pastoral land (predominantly cropland), unsurfaced roads, cleared ground and urban settlements. Natural habitats comprised steppe grassland, an ephemeral stream and a small pond with small stands of reedbeds located within the riparian zone. The Project area is dominated by grazed steppe grassland that had been modified by cutting in recent years. Small areas of scattered scrubs were present within these modified habitats. Habitats of conservational importance at the Project level are the steppe grassland, the pond and ephemeral waterbodies.

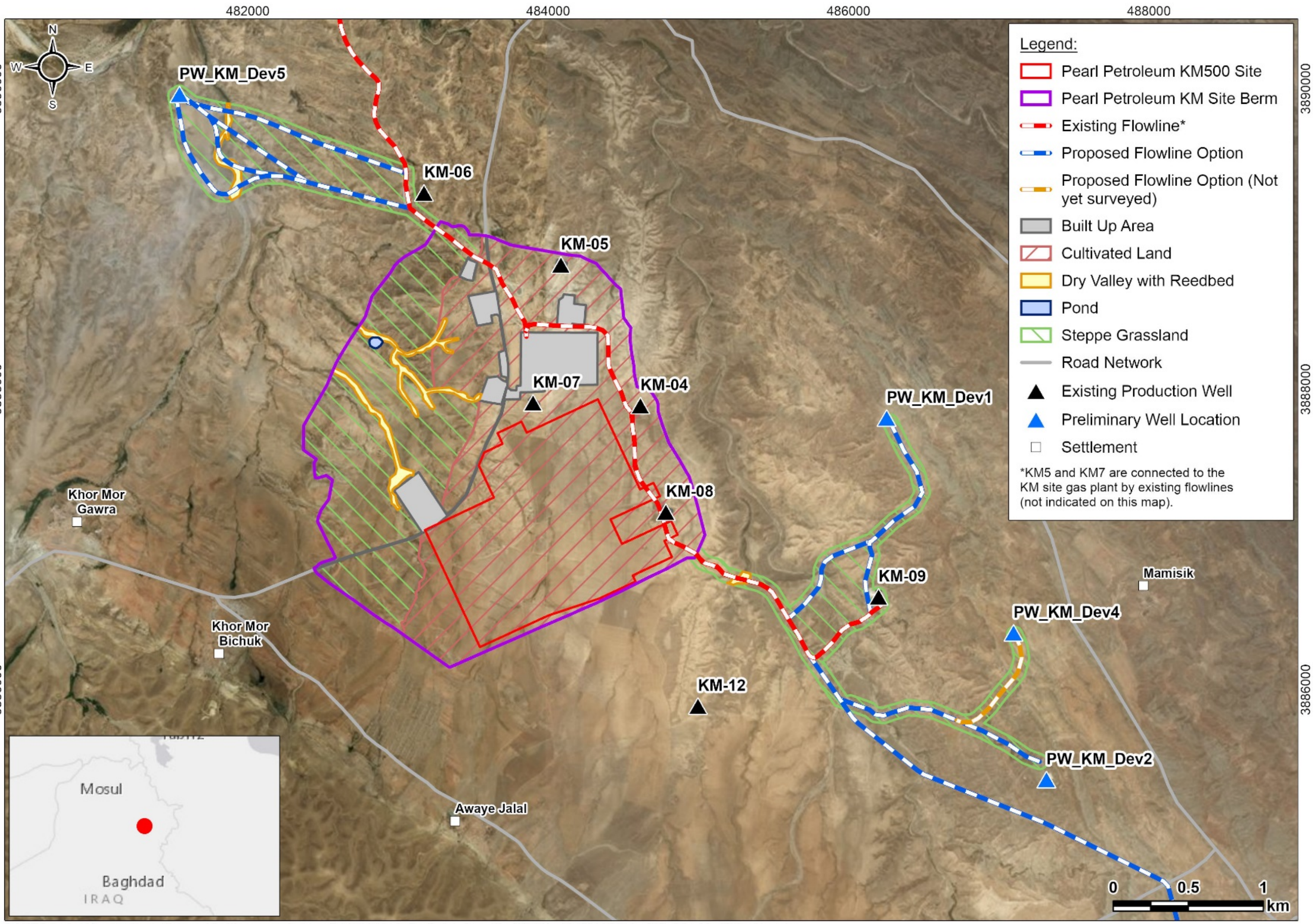

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Figure 3-9 Habitat map

Figure 3-10 Steppe grassland habitat

Figure 3-11 Typical cropland habitat with shrubs

Figure 3-12 Pond and reedbed

3.3.5.4 Flora

The botanical survey confirmed the presence of twenty vascular plant species within the study area (Appendix 4, Table A4.1). Of these, the status of only seven species have been assessed by the IUCN Red List of Threatened Species (2019). These assessed species are common and widespread in nature and as such are categorised as least concern (LC).

Most unassessed species are native to multiple countries and therefore not classed as endemics. However, the Catalogue of Life: 2019 Annual Checklist (Roskov et al., 2019) indicates that *Lomelosia leucactis* (synonym *Scabiosa leucactis*) may have a range that is restricted to north-west Iraq. Further analysis and consultation with biodiversity experts have confirmed that these species are not of conservation importance for the KM250A Project.

The literature review identified that a total of 56 species of flora were observed by MapCom (2018) as part of surveys undertaken for the development of the Khor Mor LPG facility, none of which are considered threatened (IUCN, 2019 and Nature Iraq, 2017). Ecology surveys undertaken in the Chemchemal KBA and IBA by Nature Iraq in 2008

(Nature Iraq, 2017) confirmed the presence of 57 species of vascular plants. At the time of this survey, the ecological condition of the KBA/IBA was identified as being 75% disturbed. The dominant recorded plants were the trees *Salix aegyptiaca* (not assessed by IUCN (2019)) and white poplar (*Populus alba*; LC); the shrub *Rubus sanctus* (not assessed by IUCN (2019)), the thistle (*silybum marianum*; LC) and common reed (*Phragmites australis*; LC).

Two plant species were recorded for the first time in Kurdistan, namely: *Brassica tournefortii (*LC*)* and *Euphorbia boissieriana* (not assessed by IUCN (2019)). Key flora species found within the Chemchemal KBA and IBA with potential to occur in the Project area are *Carlina kurdica*, *Pisum sativum* and *Paronychia kurdica;* three species endemic to all four parts of Kurdistan (Iraq, Iran, Syria, and Turkey) and two species which are locally endemic (Kurdistan Iraq); *Dianthus basianicus* and *Ornithogalum iraqense* are both CR according to the IUCN Red List. In addition, Xi Zang Xiao Mai (*Triticum aestivum*; IUCN 2019 listed data deficient) and *Triticum durum* (not assessed by IUCN 2019) were found in the Chemchemal area. These species are cultivars specific to the region and therefore of significance as genetic resources.

A complete list of threatened, rare and/or endemic plants is not yet available for Iraq, however Nature Iraq (2017) have proposed that five vascular plant species, presented in Appendix 4 (Table A4.1) recorded in the northern region of Iraq in 2008 should be considered. Habitats located within the study area have the potential to support these species. The conservation status of these species has been categorised by IUCN (2019) as LC, with the exception of *Quercus macranthera* and *Linum velutinum*, which have not been assessed. The Catalogue of Life: 2019 Annual Checklist (Roskov et al., 2019) indicates that *Quercus macranthera* ranges across Iran, Lebanon-Syria, North Caucasus, Transcaucasus and Turkey, whilst *Linum velutinum* may have a range that is restricted to north-west Iraq. Further analysis and consultation with biodiversity experts have confirmed that these species are not of conservation importance for the KM250A Project.

3.3.5.5 Bats

The bat survey confirmed the presence of Kuhl's pipistrelle (*Pipistrellus kuhlii)* within the study area. This species is common and widespread in nature and as such is categorised as LC by the IUCN Red List of Threatened Species (2019). This species is congregatory in nature with summer colonies typically numbering 30-100 individuals (IUCN, 2019).

There are twenty species of bat present in Iraq included on the IUCN Rd List of Threatened Species (2019). Of these, 17 are classified as LC, one is categorised as NT (the Mediterranean horseshoe bat (*Rhinolophus euryale*)) and two species are categorised as VU (the long-fingered bat (*Myotis capaccinii*) and Mehely's horseshoe bat (*Rhinolophus mehelyi*)) (Table 3-27).

The long-fingered bat is sparsely populated throughout its range and is in a state of decline throughout its range. There are isolated populations from Iberia, through the northern Mediterranean, Anatolia into Iran, Iraq and Northern Africa. The species is dependent on aquatic habitats (including artificial waterbodies) for foraging and has a roosting preference for caves. Although present in Iraq, the species range does not directly overlap the Project AOI and this species presence cannot be discounted within the wider study area.

Mehely’s horseshoe bat forages in Mediterranean scrubland and woodland, in dry steppes with particular links to water bodies (Salsamendi et al., 2012). This species almost exclusively roosts in caves or abandoned mines and doesn’t use artificial habitats. The species is largely restricted to the Mediterranean, but it does have a fragmented distribution from north Africa and southern Europe, through Anatolia to Transcaucasia, Iran and Afghanistan. The species is present in Iraq, but only in one isolated area north of Erbil (north of the Project AOI). The Project AOI lies between this population and the known range in Iran so whilst it is unlikely that the Mehely’s horseshoe bat is present in the AOI, it cannot be discounted altogether.

Table 3-27 Rare and threatened bat species within ranges that overlap the AOI

Common name	Scientific name	IUCN (2019) status	Habitat of occurrence (IUCN, 2019)
Long-fingered bat	*Myotis capaccinii*	Vulnerable	Wetlands (inland), Caves and Subterranean Habitats (non-aquatic), Shrubland
Mehely’s Horseshoe Bat	*Rhinolophus mehelyi*	Vulnerable	Shrubland, Caves and Subterranean Habitats (non-aquatic)

3.3.5.6 *Other mammals*

The 50 m perimeter wire fencing that surrounds the Project is likely to prevent access by fauna into this area thus restricting habitat usage of most medium and large sized, non-burrowing fauna species within the Project footprint (Figure 3-13 and Figure 3-14). However, gaps and push throughs were observed in some areas allowing access to mammals.

Figure 3-13 Khor Mor perimeter fence at coordinate 35.143803°(N), 44.815793° (E)

Figure 3-14 Khor Mor perimeter fence at coordinate 35.141154°(N), 44.829062° (E)

The fauna baseline survey confirmed the presence of six mammal species (Table 3-28). These species are common and widespread in nature and as such are categorised by IUCN (2019) as LC. The presence of Indian grey mongoose, wild cat, red fox and short-tailed bandicoot rat in the survey area was confirmed during the camera trapping survey (Figure 3-15).

There was some uncertainty regarding the speciation of the short-tailed bandicoot rat (*Nesokia indica*) based on the camera trapping data. Further examination of captured animal would be required to exclude the possible presence of the Bunni's short-tailed bandicoot rat (*Nesokia bunni)* as this species shares similar morphological characteristics to the short-tailed bandicoot rat. Bunni's short-tailed bandicoot rat is IUCN listed EN at the global scale and endemic to Iraq (IUCN, 2019) and as such would be of high conservation importance for the Project. However, the likelihood of the occurrence of Bunni's short-tailed bandicoot rat within the survey area is low as this species is reportedly endemic to the marshlands of south-eastern Iraq in the Tigris and Euphrates Valleys (IUCN, 2019).

Table 3-28 Mammal species identified during baseline surveys in the study area in 2019

Common name	Scientific name	IUCN (2019) status	Habitat of occurrence (IUCN, 2019)
Indian grey mongoose (Figure 3-15)	*Herpestes edwardsii*	LC	Grassland, shrubland, urban areas, dry secondary forests and thorn forests.
wild cat (Figure 3-15)	*Felis silvestris*	LC	Inhabit a wide variety of habitats including deserts, scrub grassland, forests, marsh boundaries and along sea coasts and scrub desert.
red fox (Figure 3-15)	*Vulpes vulpes*	LC	Desert, forests, urban areas, mixed landscapes with abundant "edge" of scrub and woodland, moorlands, mountains, sand dunes and agricultural areas.
short-tailed bandicoot rat (Figure 3-15)	*Nesokia indica*	LC	Tropical and sub-tropical dry deciduous forests, scrublands, grasslands, arable land, pastures, plantations, natural grasslands, cultivated fields & orchards. The species typically lives in moist soils near permanent water sources in areas of dense vegetation including agricultural areas.
golden jackal	*Canis aureus*	LC	Inhabits a wide variety of habitats including forests, grassland, shrubland and savanna
house mouse	*Mus musculus*	LC	Very wide range of man-made habitats, arable land, pastures, coastal sand dunes, salt marshes, and scrubby road verges. Tend not to be found in forests and deserts.

Indian grey mongooses (17/10/2019)

Wild cat (09/10/2019)

Red fox (07/10/2019)

Short-tailed bandicoot rat (12/10/2019)

Figure 3-15 Photographs from cameral trapping survey

The Chemchemal KBA and IBA has been recorded as supporting the goitered gazelle (IUCN listed VU at the global scale and CR in the Mediterranean) (BirdLife International, 2019b; IUCN, 2019). The goitered gazelle inhabits a wide range of semi-desert and desert habitats and has a range that extends from Mongolia and north-west China through Central Asia (Kazakhstan, Turkmenistan, Uzbekistan, and a small portion of Kyrgyzstan and Tajikistan) through Iran, Afghanistan and Pakistan. The global population is in a state of decline due to illegal hunting for subsistence and trophy hunting, and habitat loss due to economic development and agro-pastoral development. This species habitat usage is reportedly restricted to protected areas in Iran (IUCN, 2019) and as such is unlikely to inhabit the study area.

Based on secondary data, rapid screening was undertaken to determine the likely occurrence of other fauna species of conservation importance for the Project within the study area. The results are presented in Appendix 1 (Table A1.5 to A1.8). Surveys undertaken by MapCom in 2008 identified a total 12 mammals and several domesticated/livestock mammals (MapCom, 2010) but none are considered threatened (by IUCN, 2019 and Nature Iraq, 2017). In addition, the globally vulnerable goitered gazelle *Gazella subgutturosa* was reported by locals during other surveys by Nature Iraq in the region.

The literature review identified nine fauna species with IUCN ranges that overlap with the study area (IUCN, 2019). Of these, only one species has potential to occur in the Project footprint, marbled polecat (*Vormela peregusna*; global VU; Europe VU; Mediterranean VU), assuming polecats are able to climb the perimeter fence. Other species of conservation importance with potential to use habitats in the wider study area are Arabian sand gazelle (*Gazella maric*; IUCN listed VU) and striped hyaena (*Hyaena hyaena*; IUCN listed NT on the global scale and VU in the Mediterranean).

3.3.5.7 Avifauna

The ornithology survey confirmed the presence of 29 species of bird within the survey area (Appendix 4, Table A4.2). These species are common and widespread in nature and as such are categorised as LC by the IUCN Red List of Threatened Species (2019). Of these, 16 species are migratory and five species are congregatory (and dispersive) in nature. The literature review identified 12 species of rare and threatened birds with IUCN ranges that overlap with the study area and 59 species known to be present in the area from previous surveys by Nature Iraq in 2009 and 2013 as shown in Appendix 1, Table A1.7). There is potential for these species to use habitats in the study area. The Project footprint and wider study area are not considered to provide suitable habitat to support globally significant numbers of migratory and/or congregatory bird species.

3.3.5.8 Reptiles and amphibians

Two reptile species and one amphibian species were recorded by Nature Iraq during the biodiversity baseline surveys in 2019. The two reptile species, the Caspian turtle (*Mauremys capsica*) and the large-scaled agama (*Laudakia nupta*) have not been assessed by the IUCN whilst the European marsh frog (*Pelophylax ridibundus*) is categorised as LC by IUCN (2019).

According to IUCN (2019), there are nine species of herpetofauna of conservation importance that are found in Iraq which are listed as follows:

- Lake Urmia newt (*Neurergus crocatus*) - VU
- Uromastyx aegyptia - VU
- Kurdistan newt (Neurergus microspilotus) - VU
- Euphrates softshell turtle (*Rafetus euphraticus*) - EN
- Armenian viper *(Vipera raddei)* - NT
- common tortoise (*Testudo graeca*) - VU
- siirt lizard (Timon princeps) - LC
- black-headed snake (Rhynchocalamus melanocephalus) - LC
- Siebenrock’s Caspian turtle (Mauremys caspica) – near threatened.

According to IUCN (2019), the Lake Urmia newt and Kurdistan newt appear to have ranges that are located in relatively close proximity to the AOI but do not overlap directly with the Project area. The Euphrates softshell turtle and the common tortoise both have a distribution that encompass the AOI.

The Euphrates softshell turtle is almost exclusively riverine, preferring permanent and temporary tributaries and oxbow lakes, as well as slow-flowing sections of main river channels. The species has undergone a severe population decline over the last 15 years, and with Iraq encompassing the majority of its range, the species has been classed as EN. The major threat to the species has been the anthropogenic alteration and destruction of suitable habitat. Within Iraq, several marshlands were drained in the years post the Gulf war which significantly impacted the Iraqi population of the species. Oil development is also seen as a major threat to the species within Iraq (Taskavak et al. 2016).

The common tortoise's natural habitat includes semi-arid scrub and Mediterranean forest to the verges of semi-desert, where it can be found inhabiting outcrops of Euphorbia. If found in the southern parts of the species range, individuals are active during the warm winter periods and then estivate during the hotter summer. In northern ranges, this cycle is reversed (IUCN, 2019).

The Armenian viper is present in Turkey, Armenia, Nakhichevan (Azerbaijan) and Iraq, with fragmented populations also in the mountains of north-western Iran and is restricted in range to these areas. Little is known about its range in Iraq. This species is generally found in rocky montane areas with sparse scrubby vegetation at elevations above 1,000m above sea level. Animals may occasionally be found at rocky sites within woodlands (IUCN 2019).

The siirt lizard occurs in north-eastern Syria, south-eastern Turkey, south-western Iran (the central Zagros Mountains), and possibly northern Iraq (IUCN 2019)

The black headed snake ranges discontinuously from eastern Turkey, southwards to western Syria, Lebanon, Israel and western and central Jordan, possibly extreme north Saudi Arabia and eastwards to Armenia, Azerbaijan, northern Iraq and western Iran (Central Province and Khuzistan Province). It also occurs as an isolated population at Santa Katarina on the Sinai Peninsula (Egypt) (IUCN 2019).

Four subspecies of the Caspian turtle are recognized: the eastern Caspian turtle, Siebenrock's Caspian turtle, the spotted-bellied Caspian turtle, and the western Caspian turtle. Siebenrock's Caspian turtle (*M. c. siebenrocki*) occurs in Iran and Iraq, with relict populations in Saudi Arabia and on the island of Bahrain; it intergrades with *M. c. caspica* in Mesopotamia (Fritz et al 1997).

3.3.5.9 Invertebrates

No specific invertebrate surveys were undertaken as part of the baseline surveys, as such, no invertebrates were identified. In Iraq, there are 61 species of insect that have been assessed on the IUCN Global Red list of threatened species. Of these, the majority (41) are of the family Odonata – or dragonflies. Two dragonfly species, waved pincertail (*Onychogomphus flexuosus*) and dark-winged groundling (*Bracyhthemis fuscopalliata*) are classified as VU. The Apollo butterfly *(Parnassius apollo)* is also listed as VU. Four species of insect are classified as near threatened whilst the remaining 54 are either LC or data deficient.

3.3.5.10 Fish

According to IUCN (2019), there are five species of fish of conservation importance that are found in Iraq which are listed as follows:

- Mesopotamian bream - LC
- yellowfin barbel (Luciobarbus xanthopterus) - VU
- pike barbel (Luciobarbus esocinus) - VU
- binni (Mesopotamichthys sharpeyi) - VU
- leopard barbel (Luciobarbus subquincunciatus) - CR.

No riverine habitats were surveyed as part of the baseline survey.

3.4 Social baseline

The following section summarises the results of the social baseline surveys, which form part of the ESIA.

3.4.1 Methodology

3.4.1.1 Area of influence - social

The AOI for the social baseline is defined by a radius of approximately 10 km around the proposed facility. There are a total of 18 Project-affected communities (PACs) within the AOI. It is important to note that:

- This excludes the community of Aziz Bag which, although falling geographically within the AOI, has been abandoned and is currently uninhabited.
- This includes the community of Takeya Jabari which, although falling geographically outside the AOI (by approximately 5 km), has been included based on its relatively large population size (1,575), availability of social infrastructure and services (e.g. school, health care centre, local government office, police post) and location (on the main transport routes to the Project site)[8].

The AOI is divided into two spheres, based on the degree of potential influence by and proximity to the Project. The two spheres are defined as follows:

- *primary sphere of influence*: comprising PACs that may be directly affected by permanent and/or temporary loss of access to crop and/or pasture land as a result of the Project, or may experience direct health and safety risks
- *secondary sphere of influence*: comprising PACs that may be indirectly affected by the Project and the potential in-migration of people into the area.

Professional judgement, supported by a preliminary field assessment, was used to define which PACs fell into which sphere of influence. The PACs located in the AOI, disaggregated by sphere of influence, are outlined in Table 3-29 and shown in Figure 3-16.

[8] Aside from Takeya Jabari, there are no communities within 5 km of the AOI that have similarly large population sizes and available social infrastructure and services. The closest community to the AOI, which possesses such features, is Chemchemal, located approximately 65 km away.

Table 3-29 PACs within the AOI

Primary sphere of influence	Secondary sphere of influence
Awaye Jalal	Aliawa
Kani Qadir Qala	Ali Mustafa
Khor Mor Gawra	Chala Dwana
Khor Mor Bichuk	Cham Surkhaw
Mamisik	Ibrahim Ghulam
Shekh Hameed	Paryawla
Taza Shar	Qadir Karim
Zhazh	Qarah Chewar
	Takeya Jabari
	Takhta Mina Saru

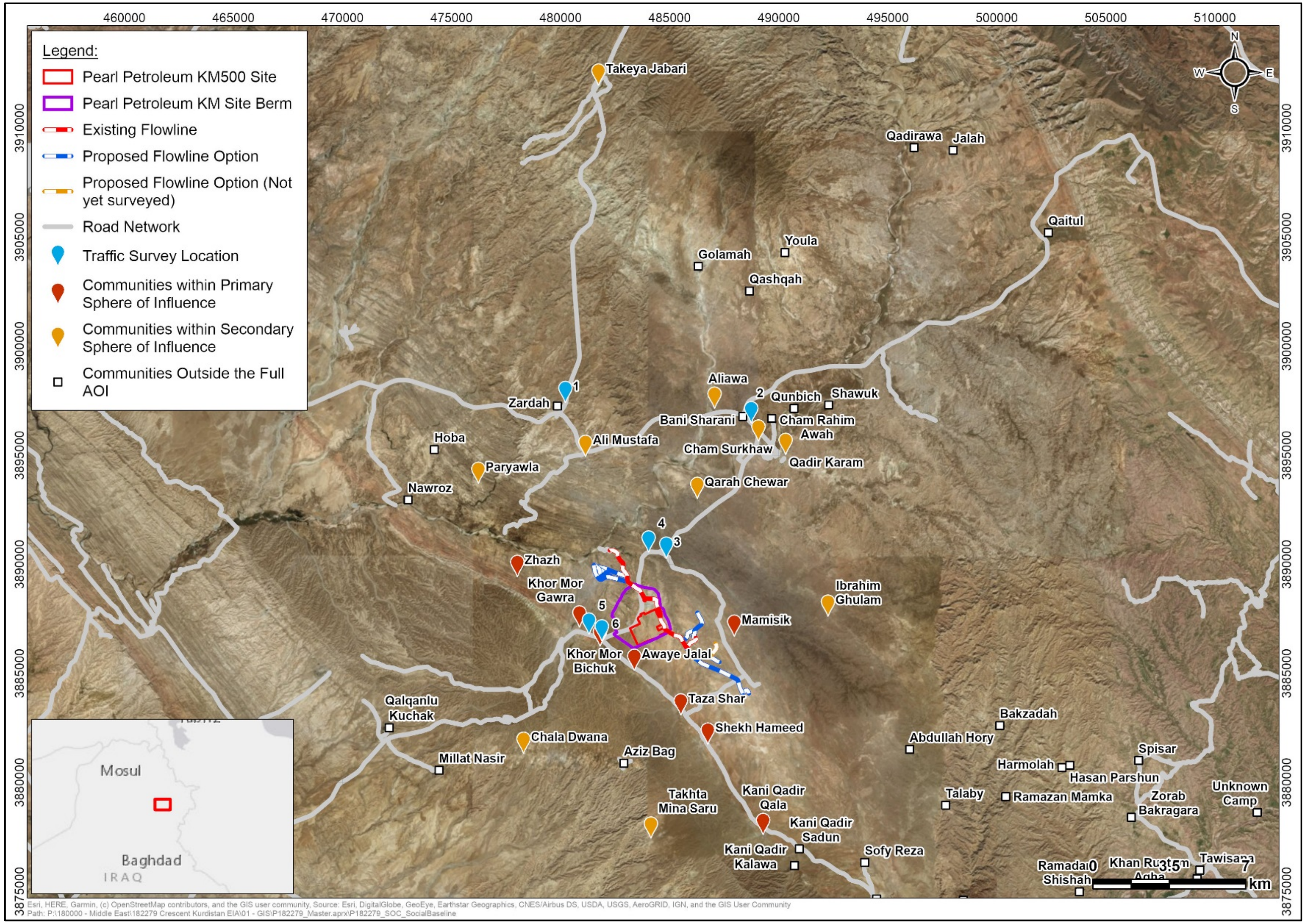


Figure 3-16 Social baseline primary and secondary spheres of influence

3.4.1.2 Data collection

Qualitative and quantitative secondary data were collected from various sources to provide contextual information at the regional and governorate level, including:

- environmental and social studies undertaken in recent years for the existing facility and proposed projects:
- ERM (2015) Khor Mor Gas Plant: Environmental Impact Assessment
- HKN Energy Limited (2018) ESIA Report for the Wellsite Production Facility, Sarsang Block, Kurdistan Region of Iraq
- the PricewaterhouseCoopers (PwC) (2018) Kurdistan Gas Project Impact Assessment Report
- MapCom (2018) ESIA Report for KM-9, KM-10 and KM-12 in Khor Mor Block
- internal documents published by CPDG
- reports published by national agencies, research institutes and international organisations
- research papers published in academic journals
- public internet sources.

Quantitative and qualitative primary data on the PACs were collected through household interviews, focus group discussions (FGD), key informant interviews (KII), visual observations of road conditions, traffic volumes and land use and an archaeology and cultural heritage walkover survey. These activities were conducted by a field team[9] between 24 September and 07 November 2019.

Table 3-30 shows the different data collection activities which were conducted in each PAC. The activities undertaken in each PAC were determined by whether the PAC was located in the primary or secondary sphere of influence (as defined in Section 3.4.1.1). In the primary sphere, more in-depth data collection (e.g. household interviews, women's focus groups) was undertaken, reflecting the expectation that these PACs may be directly affected by the Project and/or be exposed to direct health and safety risks. In the secondary sphere, less intensive data collection was undertaken, reflecting the expectation that these PACs may be indirectly affected by the Project and/or the potential in-migration of people into the area. As described above, observations of land use were made and an archaeology and cultural heritage walkover survey was also conducted in the AOI. KII and FGD were also undertaken with flowline land owners and land users.

In total, 145 household interviews were held across eight PACs (representing 80% of households in the primary sphere of influence, based on data provided by the village Anjuman).

[9] The field team consisted of six local social consultants, one local environmental consultant and an archaeologist from the University of Sulaymaniyah.

Table 3-30 Data collection activities in the PACs

Activities	Household interviews	FGD with women	KII with village leader (Anjuman) or Sub-District Manager (SDM)	KII and observations (schools)	KII and observations (health facilities)	Observations of road conditions and traffic volumes
Primary sphere of influence						
Zhazh	✓	✓	✓			
Khor Mor Gawra	✓	✓	✓	✓		✓
Khor Mor Bichuk	✓	✓	✓			✓
Awaye Jalal	✓	✓	✓			✓
Taza Shar	✓	✓	✓			✓
Shekh Hameed	✓	✓	✓	✓		
Kani Qadir Qala	✓	✓	✓			
Mamisik	✓	✓	✓			✓
Secondary sphere of influence						
Chala Dwana			✓			
Ali Mustafa			✓			
Takhta Mina Saru			✓			
Ibrahim Ghulam			✓			
Qadir Karim			✓	✓	✓	✓
Cham Surkhaw			✓			✓
Aliawa			✓			
Qarah Chewar			✓			
Paryawla			✓			
Takeya Jabari			✓	✓	✓	

3.4.1.3 Data capture, management and analysis

Household survey data were entered into a Microsoft Access database. Data was subjected to descriptive statistical analysis and descriptive qualitative analysis to inform the social baseline.

The primary data has been compiled, interpreted, triangulated and embedded within secondary data at the regional and governorate level to develop the socio-economic baseline. The data has provided the basis for the identification and assessment of Project impacts on social receptors and a robust basis for future comparison, enabling the recording and monitoring of changes that take place in the socio-economic environment as a result of the Project.

3.4.1.4 Data assumptions and considerations

For the purpose of the social baseline, it has been assumed that no significant changes will take place in the AOI between the time of data collection and the submission of the ESIA report and that data provided by the most informants (e.g. households, village Anjuman, women) is accurate and reliable.

Data considerations include (but are not limited to) the following:

- The last census was held in Iraq in 1997 and did not include the Kurdistan Region; in the absence of a formal census, secondary data from trustworthy sources (e.g. government ministries, international organisations such as the World Bank) have been utilised.
- As of March 2014, the KRI comprises four governorates (see Section 3.4.3). The most recently established governorate – Halabja – was previously part of the Governorate of Sulaymaniyah. Secondary data on Halabja is often subsumed within data on Sulaymaniyah at the governorate level and hence it is not always possible to differentiate between the two. Disaggregated data on Halabja has been provided as far as possible.
- Primary data on annual income and expenditure were difficult to obtain, with 70% of households interviewed being unwilling to disclose information due to concerns that this would influence their eligibility for employment opportunities and/or other benefits associated with the existing facility, or, in the case of low income households, concerns about pride.
- The village Anjuman of Aliawa declined to participate in an interview at the time of the social baseline surveys, the reason being that he was absent from the area at the time and was unwilling to return for the interview. To manage this problem, data provided by the Anjuman of the remaining PACs have been relied upon.
- As outlined in Section 3.4.3, 80% of households in the primary sphere of influence were interviewed. It was not possible to interview every household as some only live in the PACs part time and were not present at the time of the social baseline surveys (see Section 3.4.4). Data provided by the village Anjuman, who have extensive knowledge and a comprehensive understanding of their communities, has been used to supplement the household interview data.

3.4.2 Political history

The KRI is an autonomous federated region in Iraq which borders Iran to the east, Turkey to the north and Syria to the west. It has a distinct culture, language and national identity.

Numerous attempts at sovereignty were made during the 20th century, including revolts against the British following the First World War and during the First Iraqi-Kurdish War of the 1960s (The Kurdish Project, 2015). The KRI first became autonomous in March 1970, following an agreement between the Iraqi government and the Kurds (also known as the 1970 Peace Accord).

The Kurdistan Regional Government (KRG) was established in 2003 and referendums for independence were held in 2005 and 2017. Despite an overwhelming preference for independence amongst voters, Iraq's Supreme Court rejected the results of the 2017 referendum, ruling that the Constitution of Iraq does not allow any region to secede (DW, 2017).

3.4.3 Administrative structure and governance

The KRI has three main governance institutions:

- the KRG
- the Kurdistan Regional Presidency (KRP)
- the Kurdistan Parliament (KRG, 2019d).

The democratically elected KRG exercises executive power according to the KRI's laws, as enacted by the Kurdistan Parliament. The KRG has a total of 19 ministries and is based in Erbil, the capital of the KRI (KRG, 2019d). It maintains constitutionally recognised authority over four governorates – Erbil, Sulaymaniyah, Dohuk and Halabja – and 'de facto' authority over three governorates (Diyala, Ninawa and Kirkuk). Originally part of Sulaymaniyah, Halabja was established as a separate governorate by the KRG Council of Ministers in March 2014 (Goran, 2018). Each governorate is divided into districts, sub-districts, cities, towns and villages.

The President of Kurdistan has the highest executive authority and is elected by a secret ballot in a popular vote every four years. The President represents the people of Kurdistan at national and international levels and oversees relations between the KRI and the Iraqi federal authorities (KRG, 2019d).

The Kurdistan Parliament is the KRI's democratically elected legislature which examines proposals for new laws, scrutinises government policy and administration and debates the major issues of the day (KRG, 2019d). The Parliament comprises 111 seats representing sixteen political parties. By law, women are required to hold a minimum of 30% of the seats (KRG, 2019d) and 11 seats are reserved for parties representing minorities such as Turkmen parties, Christian parties and Armenian parties.

Administrative and planning decisions at the governorate level are made by a Governor and Governorate Council. Decision-making at the district and sub-district level are made by District Managers and SDMs. The members of the Governorate Council are elected by public vote every four years; the Council then elects the Governor. A similar process is followed at the district level; members of a District Council are elected by public vote who in turn elect a District Manager and SDMs. District Managers and SDMs are responsible for all government departments within their jurisdiction, including health, education, policing and security, agriculture, natural resources and utility services.

Neighbourhoods within cities and towns are presided over by Mukhtars. These figures are responsible for keeping records of the population, reporting safety and security issues to the police and coordinating with different local government departments for any works due to be conducted within their neighbourhood.

At the local level, decision-making falls under the remit of locally elected village leaders known as village Anjuman (in some villages in Kurdistan, the word Mukhtar is used instead of Anjuman). Anjuman play an important role in terms of representing communities and addressing their concerns, including those that involve other villages. With the SDM's authorisation, village Anjuman are empowered to sign and issue formal documents relating to the village. There are no other leaders at the village level, though village elders are widely respected figures within the community.

The AOI covers the sub-districts of Qadir Karim and Takeya Jabari in the District of Chemchemal in the Governorate of Sulaymaniyah. Except for Takeya Jabari, all of the PACs are located in the Sub-District of Qadir Karim, which has 53 villages in total (KII with SDM, Qadir Karim).

3.4.4 Demographics

The KRI population is 6,033,814 with annual growth at 2.3% (KRSO, 2019). The population of the Governorate of Sulaymaniyah was 2,021,175 in 2017, representing approximately 34% of all persons in the region that year. In 2019, population density in the KRI was 129 persons per km^2. In this respect, Sulaymaniyah is the least densely populated of Kurdistan's four governorates, with 110 persons per km^2 (KRSO, 2019).

Approximately 98% of the population of Kurdistan were born in Iraq and 99% are Iraqi citizens; a small minority (2%) were born in neighbouring countries such as Syria, Turkey and Iran (KRSO, 2019). Consistent with data at the regional level, the vast majority (98.9%) of Sulaymaniyah's population were born in Iraq and the majority (99.2%) maintain Iraqi citizenship.

The gender distribution at regional level is balanced, with males and females representing 3,029,889 (50.2%) and 3,003,925 (49.8%) of the population respectively. Consistent with the regional level, primary data in AOI showed that, of 145 households interviewed (representing 866 household members across eight PACs), 50.5% were men and 49.5% were women.

The average household size at regional level in KRI is 5.1 members, which is higher than in Sulaymaniyah Governorate, where average household size is 4.6 members. In the PACs, the average household size varied from seven in Khor Mor Bichuk to one in Mamisik.

As shown in Figure 3-17, the population of the KRI and the Governorate of Sulaymaniyah is predominantly young, with 0-24-year olds representing more than half (54.3%) of the total population at regional level and just over a half (50.8%) of the population at governorate level.

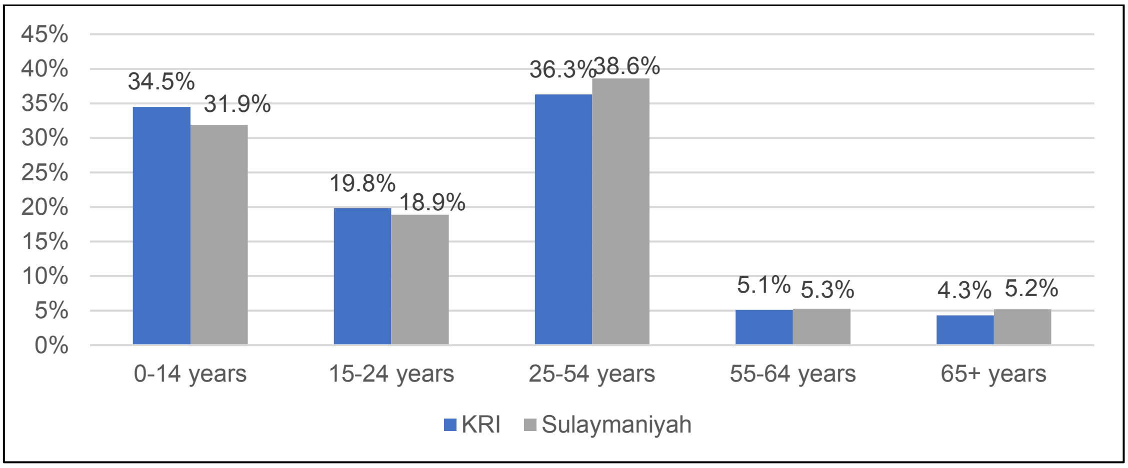


Figure 3-17 Age structure in Governorate of Sulaymaniyah and KRI, 2017 (IOM, 2018a)

There is a wide variation in population size at local level across the PACs, ranging from over 1,500 persons in Takeya Jabari to fewer than five persons in Mamisik. The majority of the communities (72%) are relatively small with less than 100 residents in total.

Table 3-31 presents a population breakdown population for the PACs in the AOI.

Table 3-31 Population and households (HH) in the PACs

PAC	Total population		Total number of HH	Full time HH[10]	Part time HH	Largest HH	Smallest HH
	Males (%)	Females (%)					
Ali Mustafa	95		19	19	-	10	3
	50	50					
Awaye Jalal	77		27	27	0	15	2
	60	40					
Chala Dwana	30		4	4	-	7	3
	70	30					
Cham Surkhaw	75		12	12	-	10	5
	50	50					
Ibrahim Ghulam	18		11	11	-	9	3
	35	65					
	70		19	15	4	15	1

[10] Full time households are households which live in the PACs on a permanent basis throughout the year. Part time households are households which, for various reasons, are absent from the PACs at certain times in the year and therefore do not live there permanently.

PAC	Total population	Males (%)	Females (%)	Total number of HH	Full time HH[10]	Part time HH	Largest HH	Smallest HH
Kani Qadir Qala		60	40					
Khor Mor Bichuk	45	40	60	25	6	19	16	5
Khor Mor Gawra	187	35	65	41	41	0	30	3
Mamisik	3	67	33	7	1	6	3	3
Paryawla	10	40	60	4	4	-	4	2
Qadir Karim	683	-	-	150	150	-	15	2
Qarah Chewar	25	70	30	3	3	-	8	3
Shekh Hameed	208	55	45	34	11	23	12	2
Takeya Jabari	1,575	50	50	-	-	-	12	2
Taza Shar	48	70	30	13	13	0	8	2
Takhta Mina Saru	20	50	50	9	9	-	10	2
Zhazh	13	39	61	15	2	13	9	2

Source: KII with village Anjuman and SDMs

Note: No data available for Aliawa (see Section 3.4.1.4 Data Assumptions and Considerations).

3.4.4.1 *Ethnic, tribal and religious affiliations and language*

As an ethnic group, the Kurds are indigenous to the Middle East (National Geographic, 2019). Kurds represent approximately 15 - 20% of Iraq's total population and the majority of people in the KRI (including Sulaymaniyah) are Kurdish (Minority Rights Group International, 2018). Other ethnic groups in the region include Arabs, Assyrians, Turkmens, Armenians, Shabaks, Roma, Circassians, Yezidis and Mandeans.

There is little variation at the local level with regards to ethnicity. 89% of households interviewed in the PACs are Kurdish; 11% are Arab. None of the aforementioned ethnic groups (Assyrians, Turkmens, Armenians, Shabaks, Roma, Circassians, Yezidis and

Mandeans) were identified in the AOI during primary baseline data collection. The Arab households living in Awaye Jalal, Kani Qadir Qala, Khor Mor Bichuk, Shekh Hameed and Taza Shar (16 in total) arrived in the PACs only recently, having been internally displaced by the Islamic State of Iraq and Syria (ISIS) conflict.

During the initial stages of the ESIA, the potential for indigenous peoples (IPs) in the AOI was investigated through a review and screening of secondary data against the criteria for IPs set forth by IFC PS7[11], supported by discussions with RSK's local in-country partner and personnel at the existing facility.

The initial finding was that, against the parameters for IPs set by IFC PS7, IPs were unlikely to be present in the AOI and therefore unlikely to be affected by KM250A Project activities. The primary data gathered during the social baseline surveys confirmed this initial finding. As outlined above, the only ethnic groups in the AOI are Kurds and Arabs. Neither groups are considered to fulfil international criteria for IPs, as set by the IFC, for the reasons outlined below.

- Kurds:
    - The KRI is a federated region in Iraq, consisting of three main institutions (described in Section 3.4.3) which are responsible for governing the population of the Region. The Kurdish people in the AOI (and KRI more generally) are governed by these institutions; no separate or unique institutions are associated with this group.
    - There is no evidence that Kurdish persons in the AOI are experiencing marginalisation and discrimination; though these may have been issues historically, they no longer appear to be issues today.
    - The majority of PAC members are Kurdish and thus cultural traits associated with Kurds (e.g. certain foods, festivals and music) are not regarded as distinguishing features which sets the group apart either within the AOI or within the KRI.
    - The land in the AOI is used by Kurdish households for crop farming and livestock rearing (see Sections 3.4.7.3 and 3.4.7.4 respectively). These activities are undertaken in addition to other activities (e.g. formal employment – see Section 3.4.7.7). Kurdish households predominantly purchase items such as food and construction materials from towns and cities, rather than relying on local habitats and territories to obtain them.
    - Kurdish people speak Kurdish, one of the KRI's two official languages.
- Arabs:
    - Arab persons in the AOI (and KRI more generally) are governed by the same institutions as Kurdish persons; no separate nor unique institutions are associated with this group. Within the AOI, Arabs (like Kurds) fall

[11] According to IFC PS7, the defining characteristics of IPs are: *self-identification* (as members of a distinct indigenous cultural group and recognition of this identity by others), *collective attachment* (as persons who identify as a group or community linked to geographically distinct habitats or ancestral territories and to the natural resources in these habitats and territories), *customary cultural, economic, social or political institutions* (separate from those of the dominant society or culture) and *an indigenous language* (often different from the official language of the country or region in which they reside). Whilst not stated by IFC PS7, *marginalisation and discrimination* are additional characteristics of IPs identified by other international organisations (e.g. the UN).

under the leadership of village Anjuman and do not have separate leaders.

- Whilst Arab persons are a minority in the AOI, there is no evidence indicating that they are experiencing marginalisation and discrimination. On the contrary, data confirming benevolence towards Arab households was collected during the social baseline surveys.
- As with Kurdish households, Arab households do not tend to rely on local habitats or territories to obtain natural resources, typically purchasing food and other items from towns and cities.
- Arab people speak Arabic. Although spoken less extensively in the AOI than Kurdish, Arabic is one of the KRI's two official languages and is not considered to be distinctive in the broader regional context.

In terms of religion, all households in the PACs are Sunni Muslims.

As indicated above, the official languages of the KRI are Kurdish and Arabic. Kurdish is the most widely spoken language of the two. The most commonly spoken dialects of Kurdish are Sorani and Kurmanji; the KRG's policy is to promote the teaching and use of both dialects in the education system and the media (KRG, 2019b). The dialect of Kurdish predominantly spoken in Sulaymaniyah is Sorani.

Of the 145 households interviewed, the vast majority of households (89%) primarily speak Kurdish whilst a minority of households (11%) primarily speak Arabic. This correlates with the ethnicity of the households interviewed (89% Kurdish and 11% Arab).

The Kurdistan Region is also home to a number of tribal groups, which are based on family then clan affiliations. Tribal groups mentioned during household interviews included the Zangana, the Gill, the Shekhanyi, the Jabari, the Dalo, the Lak and the Talabany groups. The majority of households are affiliated with the Zangana (32%), Gill (21%) and Talabany (14%).

3.4.4.2 Migration

Conflict in the region and other parts of the country (both recently and historically) has produced a highly mobile population and has played an important role in shaping Kurdistan's contemporary demographic profile.

Since 2014, Kurdistan has hosted many internally displaced persons (IDPs) fleeing armed conflict between government forces and ISIS. The Syrian War, which began in 2011, also led to the arrival of significant numbers of refugees who regard the KRI as a place of relative safety (World Bank, 2015).

As of 2019, the KRI hosts 226,000 Syrian refugees and approximately 1.5 million IDPs (EASO, 2019; KRG, 2019c); only 32,000 IDPs have returned to their homes or migrated abroad since arriving in the KRI. The Governorate of Sulaymaniyah currently hosts approximately 150,000 persons displaced by the recent conflict involving ISIS (UNOCHA, 2019). Over 90% of these persons live outside of traditional IDP camp settings and do not receive the same level of humanitarian support as those residing in camps, instead relying largely on the generosity of host communities (UNOCHA, 2019).

Internal displacement is not a new phenomenon in Kurdistan. During the 1970s and 1980s, under Saddam Hussein's Baathist regime, the destruction of Kurdish towns and villages displaced thousands of Kurdish people living close to the borders with Iran and Turkey. In 2003, there were approximately 800,000 Kurdish IDPs present in the Governorates of Dohuk, Erbil and Sulaymaniyah, the majority of whom had been displaced by the Baathist regime (Lischer, 2008).

The regional context is reflected in the AOI. Whilst no refugees were identified during primary baseline data collection, a total of 16 internally displaced families (all Sunni Arabs) were identified across five PACs. These families reportedly come from the Governorate of Diyala (including Kifri District), the Governorate of Kirkuk (including the city of Kirkuk) and the Governorate of Saladin (including the cities of Tuz Khurmatu and Tikrit). They arrived in the PACs as a result of the ISIS conflict and represent a population of 104 IDPs, 48% of whom are male and 52% female.

Consistent with data at the regional level, internal displacement is not a new phenomenon in the PACs. Several households fled from the local area during the 1970s and 1980s to escape detainment and persecution by the Baathist government. This movement intensified during the years of the Anfal campaign (KII with village Anjuman). Whilst a number of households have since returned to the PACs, the impacts of the Baathist regime and Anfal campaign can be observed in the presence of widows and other family members who lost husbands and relatives during this period.

Similar to other parts of Iraq, the KRI has undergone urbanisation, with people seeking economic opportunities not available in rural areas (Al Jarah *et al*., 2019). As many as 81.4% (4,911,795) of the region's population now live in urban areas (KRSO, 2019).

The rural-urban transition has been particularly intense in the Governorates of Erbil and Sulaymaniyah (IOM, 2018b). Data collected during the baseline surveys in the PACs supports this trend with the rural-urban migration of households witnessed in Mamisik, Kani Qadir Qala, Qarah Chewar and Takhta Mina Saru (KII with village Anjuman).

While many households live in the PACs full time, the AOI is characterised by a mobile population. Many families own properties in cities such as Kirkuk and Tuz Khurmatu where they live for several months of the year whilst their children attend school, returning to the PACs only during the holidays. A number of households left PACs such as Khor Mor Bichuk and Shekh Hameed several years ago in search of job opportunities and better services in urban areas; these households have retained their properties in the PACs, returning to them throughout the year for leisure and recreational or maintenance purposes, or to undertake seasonal livelihood activities such as crop farming and livestock rearing. Economic migrants from cities such as Mosul, Tikrit and Tuz Khurmatu have migrated to some of the PACs in search of work as shepherds (KII with village Anjuman in Ali Mustafa, Chala Dwana, Cham Surkhaw, Kani Qadir Qala and Ibrahim Ghulam).

3.4.5 Health

Life expectancy in the KRI is 75.3 years; this rate is slightly higher among women (76.7 years) compared to men (73.9 years) (KRSO, 2019).

The key regional health indicators show the following:

- total fertility rate of three children per woman, representing a decline from 3.3 children per woman in 2011 (IOM, 2018a)

- overall infant mortality rate of 23 deaths per 1,000 births, representing a decline from 28 deaths per 1,000 births in 2011 (IOM, 2018a)
- with 2.1% of children being classified as underweight, rates of malnutrition are lower than the national rate of 2.9% (UNICEF, 2018b)
- number of doctors per 1,000 members of the population in 2017 was 1.2; this figure rises to 1.6 in the Governorate of Sulaymaniyah and drops to 0.9 in the Governorate of Dohuk (KRSO, 2019).

3.4.5.1 Health problems

Table 3-32 presents the leading causes of death amongst people under and over the age of five in the KRI.

Table 3-32 Leading causes of death in the KRI in 2014 (Moore et al, 2014)

Rank	Condition	
	Deaths in children <5 years	Deaths in persons >5 years
1	Prematurity	Injury (all types)
2	Septicaemia	Cancer (multiples types)
3	Birth asphyxia	Stroke
4	Dyspnoea	Heart disease
5	Injury (all types)	Heart attack
6	Congenital malformation	Encephalitis
7	Pneumonia	Kidney failure
8	Neonatal heart failure	Diabetes
9	Gastroenteritis	Respiratory failure
10	Peritonitis	Hypertension

As shown in Table 3-32, non-communicable diseases (NCDs) such as heart disease and cancer are amongst the leading causes of death in persons over five in Kurdistan. The rise of NCDs in Kurdistan is consistent with national trends and can be attributed to factors such as economic growth and lifestyle choices (Cetorelli *et al*., 2017). Prematurity, septicaemia and birth asphyxia are the leading causes of mortality amongst children under five.

Consistent with data at the regional level, NCDs such as diabetes and high blood pressure are amongst the main health problems in the PACs. KII with medical staff in Qadir Karim and Takeya Jabari identified NCDs as being more common amongst elderly persons (i.e. those over the age of 65). Women are particularly affected by migraines and back pain; the latter was attributed to women's role in carrying water between tanks and homesteads as identified during a women's focus group in Shekh Hameed.

Injuries rank highly as a leading cause of death amongst both categories. The majority of injuries result from road traffic accidents; according to the Ministry of Health, vehicle collisions lead to approximately 850 deaths and 10,000 injuries annually (Rudaw, 2017b).

In contrary with regional statistics, injuries resulting from road traffic accidents at local level in PACs were not identified as an issue; this may reflect the low traffic volumes in rural areas. Nevertheless, this remains an issue in the KRI generally and therefore the risk of injuries resulting from road traffic accidents cannot be dismissed.

25% of households in the PACs had at least one member over the age of five suffering from a chronic illness, and for 3%, at least one member aged five or under. In 1% of households there was at least one member in each age group suffering from a chronic illness.

Based on FGD with women and KII with health staff, other less common health problems experienced in the PACs included cancer, respiratory issues, vaginal infections and heart attacks (particularly amongst the elderly). Across all interviews and focus groups, reports of respiratory problems connected to environmental issues such as air pollution were uncommon. Comments about unpleasant smells related to the existing gas processing facility were made in a small number of interviews with village Anjuman, but these were not seen to be negatively impacting upon the health of PAC members.

3.4.5.1.1 Human Immunodeficiency Virus (HIV)/Acquired Immunodeficiency Syndrome (AIDS)

Official statistics on the incidence of HIV and AIDS were unavailable at the time of writing. Media reports, however, suggest that in 2018 there were 32 patients carrying HIV and AIDS in the KRI, 23 of whom were male and nine female (Basnews, 2018). This indicates that the prevalence of HIV and AIDS across the region is low. This is supported by data at the national level; according to the WHO (2019), less than 0.1% of Iraq's population are living with HIV. HIV and AIDS were not identified as health problems in the PACs during primary baseline data collection. This could be attributed to the potentially sensitive nature of the topic or the lack of testing services available. The percentage of Kurdistan's population tested for HIV in 2018 was 7.8% (UNICEF, 2018a); neither of the primary health care (PHC) centres in Qadir Karim and Takeya Jabari offer testing services for HIV.

3.4.5.1.2 Mental health

Previous studies have shown that road traffic accidents in the KRI can have a profound psychological impact on a large proportion of survivors and on the family of the deceased. Experiences of post-traumatic stress disorder, anxiety, depression and other mental illness have been identified amongst survivors of the Anfal campaign of the late 1980s (see Section 3.4.2) (Bolton *et al.*, 2013). The more recent conflict involving ISIS has had similarly traumatic effects on survivors and placed considerable pressure on the region's health care system. The Erbil Psychiatric Hospital reportedly receives five new patients per day (EPIC, 2017).

There were limited reports of mental health problems in the PACs. Two exceptions are in Khor Mor Gawra and Khor Mor Bichuk, where one or two people with mental illnesses were identified by the village Anjuman.

3.4.5.1.3 Social ills

Substance abuse amongst adolescents, especially smoking, is becoming an increasingly important public health concern (Mahmood *et al.*, 2018). A recent survey of high school students in the capital city of Erbil found approximately 42% of students are smokers. It is estimated that, across the four governorates, approximately 10,000 individuals take illegal drugs (Ekurd, 2019).

During interviews with households in PACs, social ills were not reported.

3.4.5.1.4 Nutrition and food security

Kurdish households experience greater food security and daily calorie intake levels than households in the rest of Iraq (World Bank, 2015). A person in the KRI consumes, on average, 3,100 kilocalories per day whereas a person in the central and southern governorates of Iraq consumes, on average, 2,510 calories (World Bank, 2015).

Consistent with data at the regional and governorate level, food security is not a major health concern in the PACs, having reportedly improved in recent years. Data gathered during women's FGD and interviews with village Anjuman and SDMs indicate that households are generally able to secure enough food year-round. Moreover, malnutrition is not an issue that affects local children (KII with health staff).

Nevertheless, of 145 households interviewed, one or two households were identified as being food insecure in Cham Surkhaw and Takhta Mina Saru (KII with village Anjuman) and relied on support from other community members.

3.4.5.1.5 Women's health

The KRI out-performs the rest of Iraq with respect to several aspects of women's health. Maternal mortality rates are lower in the KRI compared to Iraq as a whole, at 30 deaths per 100,000 live births compared to 84 (Shabila and Al-Hadithi, 2018; Vilardo and Bitta, 2018). Moreover, the proportion of women receiving postnatal care across the KRI is higher; the results of a survey conducted by the Ministry of Planning (2012) found that approximately 47% of women from the KRI received postnatal care after their last birth compared to approximately 38% at the national level.

Nevertheless, many challenges to women's health in the KRI, and the following remain the most significant:

- an average prevalence rate of 40% for female genital mutilation (FGM): this figure is highest in Sulaymaniyah, reaching close to 70% in some rural parts of the governorate (Ahmed et al., 2019)
- high levels of violence against women: a recent study found that 45% of female participants had experienced spousal violence in the previous year and 59% over the course of their lifetime (Shabila and Al-Hadithi, 2018).

A number of positive steps have been taken towards improving the situation surrounding women's health in the KRI, including the passing of a law on domestic violence and the establishment of an increasing number of local non-governmental organisations (NGOs) which advocate for women's rights (Qudrat and Jaff, 2019).

Data on FGM and the incidence of violence against women could not be obtained during primary baseline data collection. Whilst KII with village Anjuman and medical staff confirmed that gender-based violence (GBV) is an issue in the PACs (corroborating data at the regional and governorate level), the rate of violence is unknown. This was attributed to the fact that GBV predominantly occurs within the household and is regarded by most people as a private matter (KII with medical staff). Despite this, medical staff indicated that the situation surrounding GBV has improved in recent years due to the increasingly educated nature of the local population and awareness campaigns on social media.

3.4.5.2 Access to health care services

Access to public health care is guaranteed by the KRG's draft constitution. A study by Moore et al. (2014) concluded that public health care access is generally good. The majority of persons live within 30 minutes of some form of PHC centre, most of which provide most of the basic primary care services for a very low price (World Bank, 2017).

PACs appear to have reasonable access to health care, supporting data on access to health care at the regional level. Most households interviewed (80%) sought medical treatment from a medical health facility for their illnesses and ailments (see Figure 3-18).

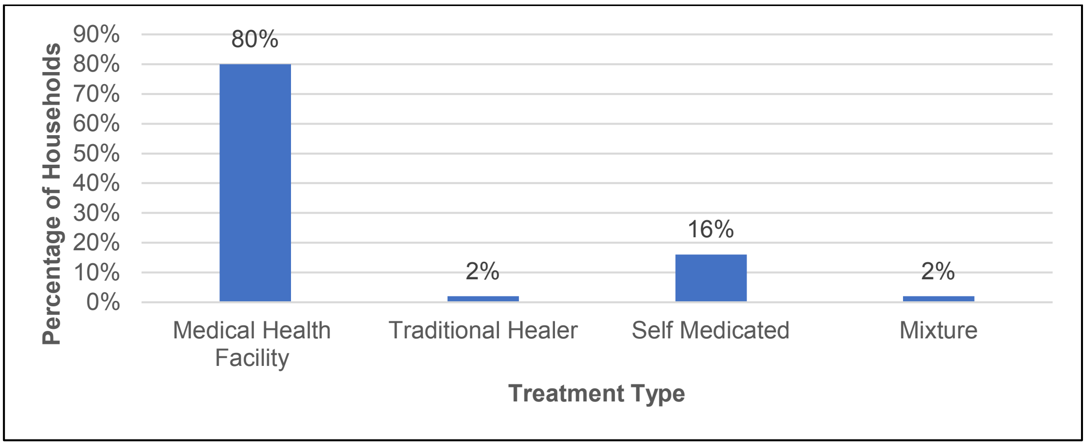


Figure 3-18 Treatment type sought by households

Source: Household interviews

There are two PHC centres within the AOI, namely Qadir Karim Medical Centre and Takeya Jabari Health Care Centre. These centres are located approximately nine km and fifteen km from the existing facility respectively.

Of the 145 households interviewed, 28% seek medical treatment from Qadir Karim Medical Centre. None of the households reported visiting Takeya Jabari Health Care Centre for treatment; this may be attributed to the fact that Qadir Karim Medical Centre is the nearest facility to the PACs and the types of services offered are very similar. Despite this, the quality of services and care available at Qadir Karim Medical Centre was consistently described as poor (FGD with women), motivating PAC members to seek medical treatment from facilities outside the AOI. Whilst the costs associated with using these facilities are unknown, PAC members indicated that they are generally accessible.

There are no hospitals in the AOI. The nearest hospital is located approximately 140 km from the PACs in the city of Chemchemal. Ambulance transportation from the PHC centres in Qadir Karim and Takeya Jabari to the hospital in Chemchemal is available to patients free of charge. Nevertheless, the most commonly cited medical facility after Qadir Karim's was Kirkuk Hospital, accounting for 21% of households interviewed. PAC members also use hospitals in the city of Sulaymaniyah.

A small proportion of households interviewed (20%) chose alternative treatment options. This was mainly attributed to a combination of two factors: distance and/or cost, which indicates that health care access remains an issue for some members of the PACs.

3.4.5.3 *Cultural health practices*

Studies have shown that traditional medicine is used to treat a variety of health problems in Kurdistan. A survey of traditional healers in the Governorate of Erbil identified the use of 32 plants to treat ailments such as common cold, hypertension, allergies, ulcers and arthritis (Naqishbandi, 2015). In the Governorate of Sulaymaniyah, research conducted by Ahmed (2016) found that medicinal plants also play an important role in the treatment of respiratory issues, inflammation and ‘women’s’ diseases.

At the local level, however, traditional medicine was not reported as a common form of medical treatment in the PACs. Of the 145 households interviewed, only 2% reported seeking medical assistance from a traditional healer (see Figure 3-18). In support of this finding, the harvesting of wild plants for medicinal purposes was not reported during discussions around natural resource use in interviews and focus groups with households, land owners and land users.

3.4.6 Education

3.4.6.1 *Education system*

Schooling in the KRI consists of three levels: basic school (covering classes one to nine), high school (covering classes 10 to 12) and higher education (Vernez *et al*., 2016). Basic school (primary education) is compulsory for all individuals and starts at the age of six.

In September 2015, Kurdish replaced Arabic as the main medium of instruction for the first three years of primary education (PA, 2017).

Public education is funded by the KRG and provided free of charge, from primary through to secondary school. A number of private establishments provide education for a fee, ranging from 100 United Stated dollars (USD) to 4,000 USD annually, depending on the institution (PA, 2017).

3.4.6.2 *Literacy rates and school attendance*

As of 2018, over 45% of Kurdistan’s population aged six years and above have no primary education. Despite this, 79% of people can read and 78% can write, indicating an illiteracy rate of approximately 21%. In Sulaymaniyah, 34.2% of the school aged children (aged 6 to 17) are currently attending school, 48.8% are enrolled but not attending and 17.1% have never attended school (IOM 2018a).

Literacy rates in the PACs are low relative to the KRI as a whole. In Shekh Hameed, Khor Mor Gawra and Takeya Jabari between 60 and 65% of the population are literate, increasing to 75% in the case of Qadir Karim (KII with schoolteachers).

Literacy is gender-biased and only 70% of females at the regional level can read and write, compared to around 85% of males (IOM, 2018a). Consistent with regional level, data on literacy and gender at local level also varies. Interviews with school teachers revealed that 80% of men and 70% of women were literate in Qadir Karim, followed by 75% of men and 50% of women in Shekh Hameed, 70% of men and 55% of women in Takeya Jabari and 75% of men and 25% of women in Khor Mor Gawra.

The number of students enrolled in public and private schools varies geographically, with the greatest number of students enrolled in the Governorate of Sulaymaniyah, reflecting the larger population size of this governorate relative to Erbil, Dohuk and Halabja (IOM, 2018a) (see Figure 3-19).

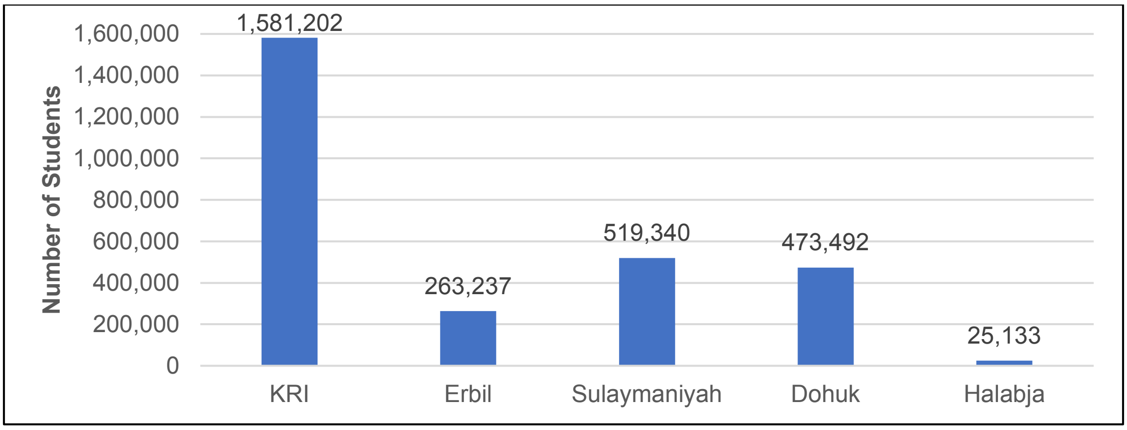


Figure 3-19 Students enrolled in public and private schools in the KRI, 2017 – 2018 (KRSO, 2019)

FGD with women in PACs indicated that children's education is considered to be highly important. Consistent with this belief, primary school attendance rates in the PACs are high. In Shekh Hameed, Khor Mor Gawra, Qadir Karim and Takeya Jabari, between 95% and 100% of children are attending primary school on a regular basis (KII with schoolteachers). School attendance rates decline at the secondary level with rates of 60%, 40% and 30% reported in Khor Mor Bichuk, Khor Mor Gawra and Taza Shar respectively (FGD with women). Consistent with data at the regional level, secondary school attendance rates are lower amongst girls from the PACs. Fears around the mixing of boys and girls and the potential for relationships to start at an early age (i.e. before marriage) were cited during KII with teachers and FGD with women.

According to interviews with women in PACs, while some children attend schools in the AOI, the majority of households send their children to schools outside the AOI (see Figure 3-20).

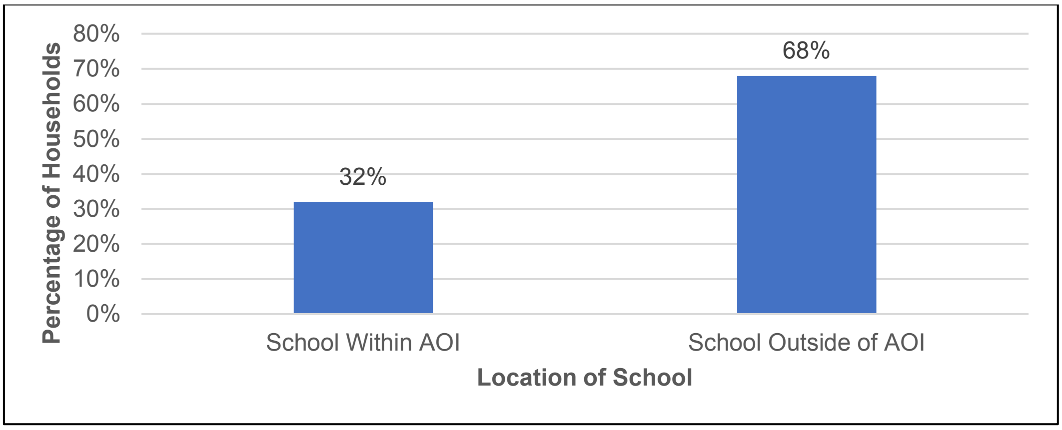


Figure 3-20 Children attending school within versus outside the AOI

Source: Household interviews

There are four schools in the PACs, specifically Qadir Karim Primary and Secondary School, Takeya Jabari Primary and Secondary School, Shekh Hameed Primary School and Khor Mor Gawra Primary School.

None of the households with children of school-going age send their children to Takeya Jabari Primary and Secondary School; this may be attributed to the fact that the other three schools are closer to the PACs. Moreover, observations at Takeya Jabari Primary and Secondary School indicate that the infrastructure of the school is in poor condition relative to the other schools in the AOI.

As shown in Figure 3-20, the children of families in PACs such as Khor Mor Gawra and Paryawla attend school in cities such as Kirkuk and Tuz Khurmatu. An additional 20 primary schools and 25 secondary schools outside the AOI were identified during the household interviews. Households' decision to send children to such schools reflects the fact that most PACs do not have their own school, particularly at the secondary level. Whilst the quality of education does not differ markedly in cities, schools in these locations are also favoured because of the greater availability of teachers.

3.4.6.3 Higher education

There are numerous public and private universities in the KRI. The majority of Kurdistan's students attend public universities, which tend to be much larger than private universities and do not charge tuition fees. The average annual cost of tuition fees at a private institution is 2,000 USD (PA, 2017).

The largest universities across the KRI are Salahaddin University – Erbil, the University of Sulaymaniyah and the University of Dohuk. The University of Sulaymaniyah offers undergraduate and postgraduate degrees in various fields of study including engineering, science, administration and economics. In the 2016-2017 academic year, a total of 22,555 undergraduate students and 1,211 graduate students were enrolled at the university (University of Sulaymaniyah, 2017).

There are no universities in the AOI; consistent with data at the regional and governorate level, students from the PACs must travel to cities to attend university. The closest university to the PACs is Charmo University, located in the city of Chemchemal. Charmo University consists of two colleges – the College of Public Administration and Natural Resources Management and the College of Education and Natural Sciences – and 10 departments. Discussions about opening new departments in fields such as petroleum engineering are currently underway, reflecting the growth of the oil and gas industry and associated labour market requirements in recent years (CPDG, 2018a).

Anecdotal evidence indicates that approximately 50 students from Qadir Karim Primary and Secondary School go on to study at university every year. However, only one of the households interviewed has a member that is currently attending university (located in Kirkuk). Moreover, very few members of the households interviewed have a technical vocational qualification or university degree.

3.4.7 Economy and livelihoods

The Gross Domestic Product (GDP) of the KRI in 2017 was USD 28.1 billion, representing 20% of the GDP of Iraq (PwC, 2018). The region has achieved high rates of economic growth over the past decade, averaging 12% in 2012 and 8% in 2013 (Invest in Group, 2013a). Following the cessation of Saddam Hussein's government in 2003, the Governorate of Sulaymaniyah has experienced an economic boom, owing to a substantial increase in foreign investments and tourist arrivals (NGO Coordination Committee for Iraq, 2015). Figure 3-21 presents the distribution of the KRI's GDP by sector.

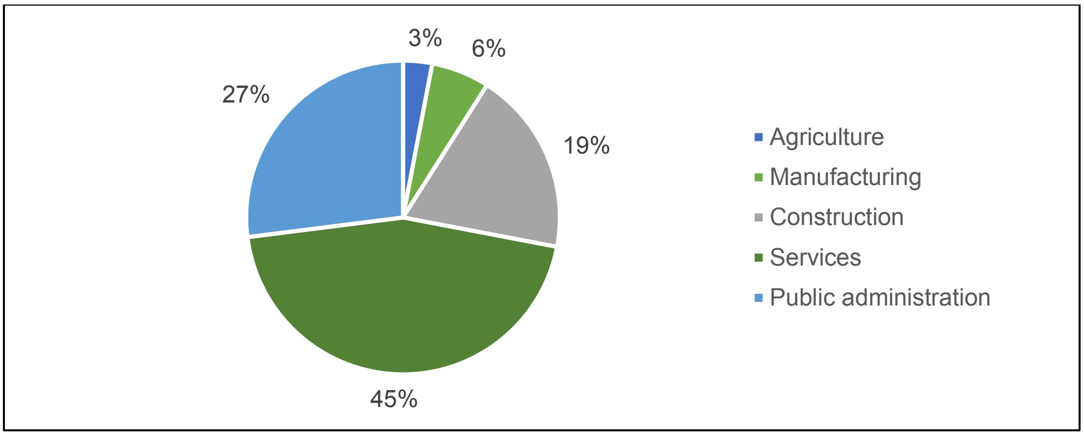


Figure 3-21 Distribution of GDP by sector, 2017 (PwC, 2018)

Kurdistan's economy is heavily dependent on services and public administration, which represent 45% and 27% of the KRI's GDP respectively (see Figure 3-21. The manufacturing sector at regional level remains nascent and only a small proportion of GDP is derived from agriculture (PwC, 2018).

The importance of the different economic sectors varies considerably geographically. Thus, there is a predominance of crop farming and livestock rearing in rural areas and in the Governorate of Sulaymaniyah as a whole.

The main economic activities in PACs are the agricultural sector (crop farming and livestock rearing), followed by formal employment in public and private sectors.

According to OPEC (2013 cited in Kamal, 2018), the KRI has approximately 43.7 billion barrels of proven oil reserves and between 3 and 6 trillion cubic metres of gas, representing 30% of Iraq's proven oil reserves and 89% of all gas reserves nationwide. With plentiful supplies, the oil and gas sector is regarded as integral to the region's economic development (PwC, 2018). Kurdistan's oil sector developed rapidly between 2007 and 2013; by the end of 2013, the KRG had issued 58 Product Sharing Contracts with foreign and local companies (Heshmati and Auzer, 2018).

Notwithstanding the overall trend in economic development, the KRI experienced an economic crisis in 2014, triggered by plunging oil prices (World Bank, 2016a). This intensified pressure on the region's economy, exposing the dangers associated with being over-reliant on the energy sector (Heshmati and Auzer, 2018).

Households in the AOI have diversified livelihood strategies and tend not to rely on single income sources. The main types of livelihoods are farming, livestock rearing, formal employment and small businesses/services.

3.4.7.1 *Business and enterprise*

A variety of businesses have been established in the Kurdistan Region. Statistics provided by the Kurdistan Region Statistics Office (KRSO, 2019) indicate that there are approximately 5,800 restaurants and cafes, 91,000 wholesale and retail traders and 3,000 street vendors. Wholesale and retail trade generated close to 172,000 jobs and an overall income of approximately USD 2.8 million in 2013.

However, the establishment of new businesses can be a lengthy and complicated process (IRIS, 2017a). Further challenges to private sector development relate to the region's weak financial infrastructure and low access to finance (World Bank, 2016a).

Consistent with the data gathered during household interviews, there is a very low level of business and enterprise development in the AOI. Amongst local businesses, particularly small ones, there is a strong preference for cash in business transactions; approximately 3% of companies in Kurdistan rely on the banking sector for investment and working capital, compared to 20% in other parts of the Middle East and North Africa (World Bank, 2016a).

There are very limited businesses providing goods and services, except in Qadir Karim and Takeya Jabari, which have considerably larger populations than the other PACs. Qadir Karim was commonly identified as a place where people go to buy basic items such as food during focus groups with women. However, other household items (e.g. furniture, clothes, school materials, livestock and farming equipment) are typically purchased from further afield. In both household interviews and women's FGD, Chemchemal was identified as the main location from which to buy goods and services outside the AOI, followed by Kirkuk and Tuz Khurmatu.

It is important to note that business development at local level is closely linked to the existing facility with third party contractors and sub-contractors (CPDG, 2019f), many of whom are local to the AOI, competing for work. In this context, Pearl Petroleum plays an important role in the generation of opportunities in fields such as construction, transportation and operations for local companies, where they exist. Stakeholder engagement conducted as part of the ESIA indicates that local companies expect to be prioritised over those from other parts of the district and wider region when new business opportunities arise.

3.4.7.2 *Tourism*

With its relative political stability and security, abundance of natural attractions and approximately 3,500 historical and religious landmarks, there is potential for tourism in Kurdistan (Altaee *et al*. 2017). As of 2017, the region received approximately 2.25 million (predominantly domestic) tourists, representing an increase from 1.8 million in 2016 (Foreign Policy, 2019). Cities such as Sulaymaniyah and Erbil have been promoted based on their offering of first-class hotels, cultural features (e.g. museums, a citadel) and leisure activities (e.g. shopping malls and theatres) (General Board of Tourism of Kurdistan, 2015b).

Tourism is not a major income source in the PACs. Nevertheless, interviews with village Anjuman and SDMs revealed that tourists visit the following PACs during Spring (March, April and May): Awaye Jalal, Cham Surkhaw, Kani Qadir Qala, Ibrahim Ghulam, Qarah Chewar, Qadir Karim, Takeya Jabari and Zhazh. Interviewees stated that tourists are attracted by the natural landscapes and scenery of the local area. Tourists typically visit the PACs on day trips, though some stay for two or three days. The majority of tourists stay with relatives and thus it is not common to rent accommodation; some tourists camp in tents along the edges of streams and near seasonal springs.

3.4.7.3 Crop farming

As of 2017, there are approximately 6.42 million donums[12] of arable land in Kurdistan, equivalent to approximately 642,000 hectares (KRSO, 2019). The vast majority of arable land (approximately 5 million donums or 500,000 hectares) is rain-fed; the remainder is irrigated (Ministry of Agriculture, 2017 cited by KRSO, 2019). The average amount of arable land cultivated by farmers is approximately 100 donum, equivalent to 10 hectares. During the growing season of 2001/2002, about 676,500 metric tons of crops were harvested in the governorates of Erbil and Duhok alone.

A wide variety of crops are grown in the KRI, including grains (e.g. wheat, barley, rice, corn), vegetables (e.g. tomatoes, cucumbers, eggplants) and fruits (e.g. grapes, apples, pomegranates) (World Bank, 2015). The KRI's share of national crop production is high with cereals such as wheat, rice and barley being the most common crops and representing approximately 90% of KRI's total agricultural output (World Bank, 2016a).

However, statistics provided by the Ministry of Agriculture indicate that approximately 7 billion USD worth of fruit and vegetables were imported into the Kurdistan Region between 2004 and 2014 (Ekurd, 2017). This suggests that cultivation of crops that requires intensive irrigation is often a challenge for the region dependent on the rainfall as a water source.

Consistent with data at the regional level, grains such as wheat and barley were listed as primary crops grown by the households interviewed during primary baseline data collection in FGD and KII (see Figure 3-22). According to a land owner in Khor Mor Bichuk, rice and alfalfa is also cultivated, albeit to a lesser extent. 'Other' produce (e.g. tomatoes) are primary crops for a small minority of households due to irrigation challenges (FGD with land users, Qarah Chewar and Taza Shar).

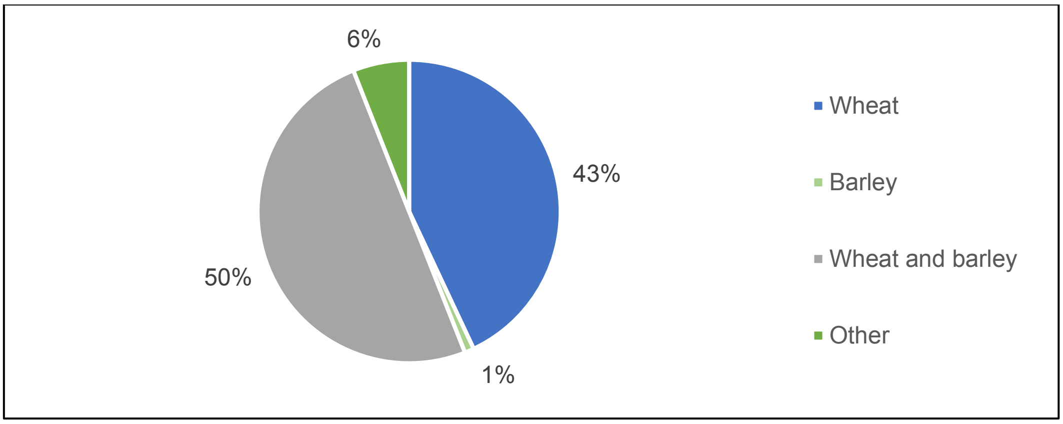


Figure 3-22 Primary crops grown by households

Source: Household interviews

[12] A donum, also known as *dunam* or *dunum*, was the Ottoman unit of land area equivalent to the English acre. It remains in widespread use in the KRI today. One donum is equivalent to approximately 0.25 acres or 0.1 hectares.

The average size of agricultural land holdings in the AOI is 80 donums (or 8 hectares). The amount of wheat and barley produced by households in a given year varies depending upon the fertility of the land and levels of rainfall (KII with land owner, Khor Mor Bichuk). Data gathered during household interviews indicates that, on average, nine tons of wheat and 21.1 tons of barley are produced annually per household. Annual levels of barley production ranged from one to 35 tons amongst households interviewed. Annual levels of wheat production ranged from 0.5 to 60 tons except for one household, which reported produces 300 tons of wheat per year.

The main challenges associated with crop farming reported during baseline data collection included damage caused by pests, insects and occasionally livestock; a shortage of water for irrigation, the risk of crops catching fire during hot weather and in the dry season; and a decline in government support for farmers.

3.4.7.4 *Livestock rearing*

In KRI, animal husbandry is widely practiced and constitutes an important source of income and subsistence. Popular animals used for breeding include sheep, goats, buffalo, cattle, and chickens. Some of this production is large-scale, representing the main source of income for the farmer. Small-scale "backyard" livestock production is common, with families keeping small numbers of livestock and poultry. Animal products and meat are periodically sold for cash income, and animal products are consumed within the household as an important source of protein.

Consistent with data at the regional level, livestock such as sheep, goats and chickens are the most commonly owned by the households interviewed during primary baseline data collection; a smaller proportion of households own ducks, donkeys and cattle (see Figure 3-23).

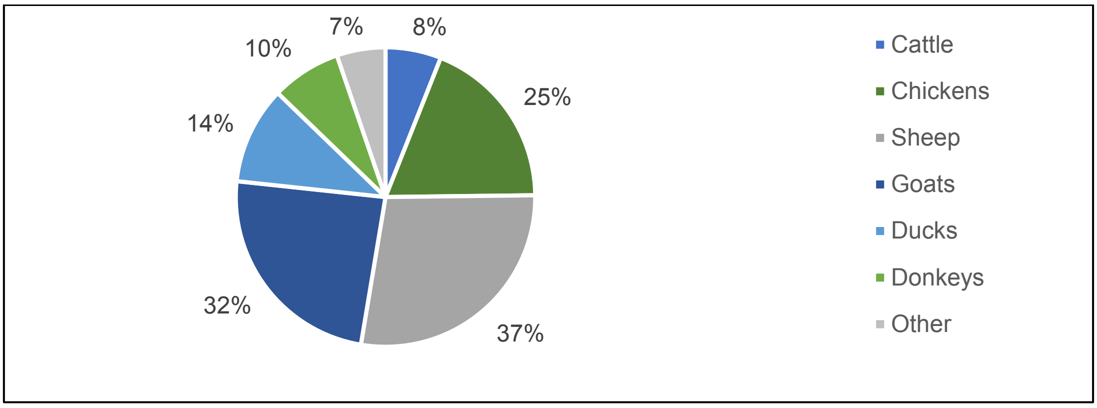


Figure 3-23 Livestock owned by households

Source: Household interviews

The average number of livestock owned by the households interviewed varies according to livestock type (see Table 3-33).

Table 3-33 Number of livestock owned amongst households

Livestock	Average number owned	Smallest number owned	Largest number owned
Cattle	9	1	50
Chicken	29	2	230
Sheep	167	2	650
Goats	77	5	500
Ducks	7	1	25
Donkeys	1	1	3

Source: Household interviews

Livestock types and numbers vary widely between households and across the PACs. Chickens, sheep and goats were identified during household interviews in all the selected PACs; no cattle were identified during household interviews in Awaye Jalal, Kani Qadir Qala, Khor Mor Gawra, Mamisik and Zhazh. The number of sheep ranged from two to 10 amongst households interviewed in Khor Mor Bichuk, compared to between 70 to 550 amongst households interviewed in Kani Qadir Qala. The number of chickens ranged from seven to 230 in Awaye Jalal, compared to a range of six to 50 in Shekh Hameed.

Livestock rearing is a year-round activity and the income is mainly derived from sale at livestock markets in cities such as Chemchemal. During Eid Qurban, PACs may sacrifice meat for poorer members of the community.

Access to grazing land is a vital provisioning ecosystem service for livestock rearers. During focus groups with land users in Taza Shar, Qarah Chewar and Khor Mor Gawra, it was reported that while grazing predominantly takes place on village land adjacent to the PACs, some use pastures located between 2 to 5 km from the PACs. Individuals travel to these pastures with a few other household members or in small groups with other households.

Groundwater is a key provisioning ecosystem service providing water for livestock; seasonal springs and ponds are relied upon to a lesser extent (household interviews, FGD with land users). An example of a groundwater well used to water livestock in Takhta Mina Saru is presented in Figure 3-24. A generator is used to pump water to a storage area on the surface where it is consumed by livestock.

During primary baseline data collection, water scarcity and poor water quality were commonly cited issues in the context of livestock rearing. According to focus group participants in Taza Shar, groundwater well water levels are decreasing, corroborating trends at the regional level with regards to the declining availability of groundwater across the KRI.

Figure 3-24 Livestock well in Takhta Mina Saru

3.4.7.5 Fisheries and aquaculture

Fishing is uncommon in the vast majority of the PACs, owing to the lack of water resources available (household interviews, KII with village Anjuman and SDMs). Two exceptions are Ali Mustafa and Cham Surkhaw; in these PACs, aquaculture is undertaken by residents in small private dams which accumulate water from seasonal springs. The type of fish cultivated is carp. The dams in Cham Surkhaw are currently in need of repair (KII with village Anjuman).

3.4.7.6 Natural resource use

Natural resource harvesting is an important source of income in a small number of PACs. Rainwater, freshwater from streams and seasonal springs, wild foods (e.g. berries, nuts, mushrooms), grasses, wood, stones and clay were identified by the households among natural resources collected locally. Wood and mud for livestock enclosures and shelter and grass or vegetation for livestock grazing are the most common types of natural resources collected, collected by 31% and 30% of households respectively. Approximately one fifth of households (22%) collect stones and aggregates for construction. Wood and mud were mentioned as common construction material used for livestock shelters, while grass and vegetation were collected to feed the livestock and for heating. Three households reported use of river sand and clay for construction and pottery.

Whilst over 10,000 people practice beekeeping in the KRI, apiculture is uncommon in the PACs (FGD with land users). Only three or four hives belonging to a household in Khor Mor Gawra were observed during primary baseline data collection.

3.4.7.7 Employment

Precise data on employment by sector were unavailable at the time of writing. Accounting for more than 50% of employment (26% in non-military employment), the KRG is the main employer in the region (World Bank, 2016a). This is one of the highest public sector employment rates in the world.

The public sector employs 75% of the working women. Men's occupational status is more varied, with 44% of working men in the public sector, 12% in the private sector, 21% are daily workers, 21% self-employed and 2% unpaid family workers (IOM, 2018a).

The KRG has been working to transition public sector employees into the private sector (Joseph and Sumer, 2019). The success of this strategy has been limited by a weak private sector that lacked long-term investment and historical reliance on public sector as the most secure type of employment.

Formal employment was identified as an important source of income in all PACs, except for Awaye Jalal, Chala Dwana and Mamisik. The extent of formal employment as a percentage of household members varies across PACs (see Figure 3-25). Whilst 24% of household members interviewed in Taza Shar are formally employed, far fewer (7%) are formally employed in Kani Qadir Qala. (No household members are formally employed in Mamisik, but this PAC consists of only one household).

The existing facility is a leading employer in the PACs, making the AOI atypical of the region, where the public sector is still the dominant source of formal employment. The availability of jobs at the facility, coupled with the limited opportunities for employment locally, has created high expectations of Pearl Petroleum in relation to employment amongst PAC members.

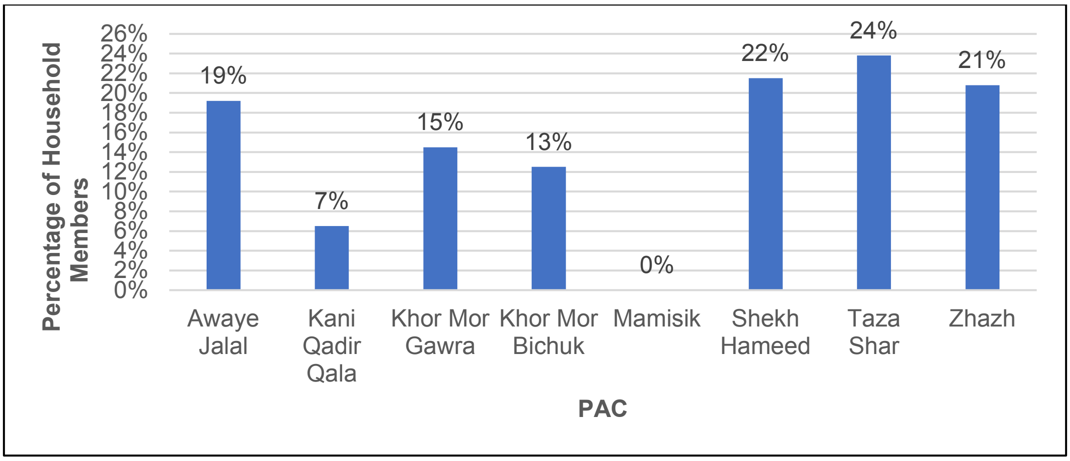


Figure 3-25 Percentage of formally employed household members

Source: Household interviews

Note: Percentages shown excludes those unable to work because of age, educational commitments, retirement or disability.

Recruitment at the existing facility follows an established process whereby the SDM of Qadir Karim is engaged by and agrees with Pearl Petroleum the distribution of employment opportunities across the local communities; contractors and sub-contractors are required to honour this agreement when hiring personnel. Support is provided to persons who experience difficulties with reading and writing when applying for employment at the existing facility.

As of 2018, the KRI had an overall unemployment rate of 9%, declining from 13% in 2015 (PwC, 2018). Unemployment is higher amongst females (20.1%) compared to males (8.1%) and particularly affects young people. Many unemployed youths are university graduates, owing to the fact that the KRI's education sector has developed at a rate faster than the labour market can absorb (World Bank, 2015).

Unemployment also varies geographically, with higher rates reported in Dohuk compared to Erbil and Sulaymaniyah (see Figure 3-26) (KRSO, 2019).

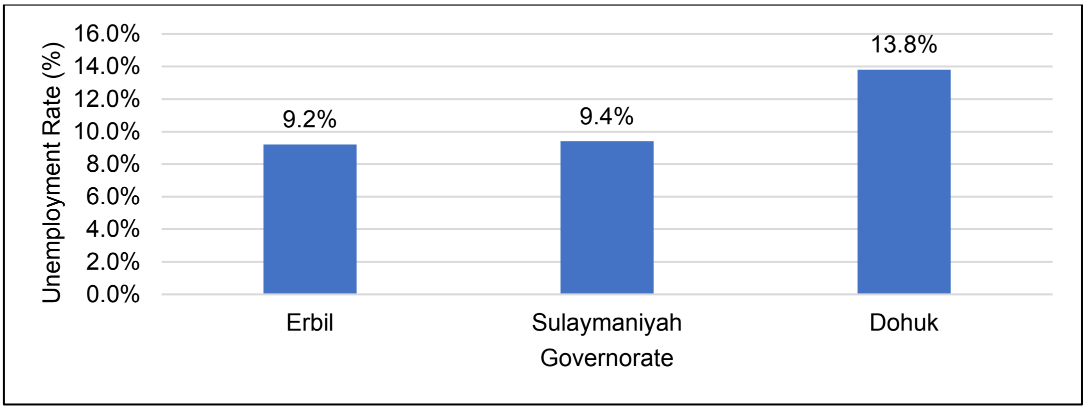


Figure 3-26 Unemployment by governorate, 2017 (KRSO, 2019)

Note: No data available on the unemployment rate in Halabja.

Unemployment rates in the PACs are extremely high relative to the region. Approximately 80% of household members were unemployed at the time of the household survey, of whom 69% were actively seeking work and 31% were not. These figures exclude those unable to work because of age, educational commitments, retirement or disability.

Figure 3-27 shows unemployment as a percentage of household members interviewed across the PACs. Over 60% of household members interviewed in Kani Qadir Qala, Khor Mor Bichuk and Mamisik were unemployed and seeking work at the time of the household survey. Except for Khor Mor Gawra, 20% or more household members in the PACs were unemployed and not seeking work.

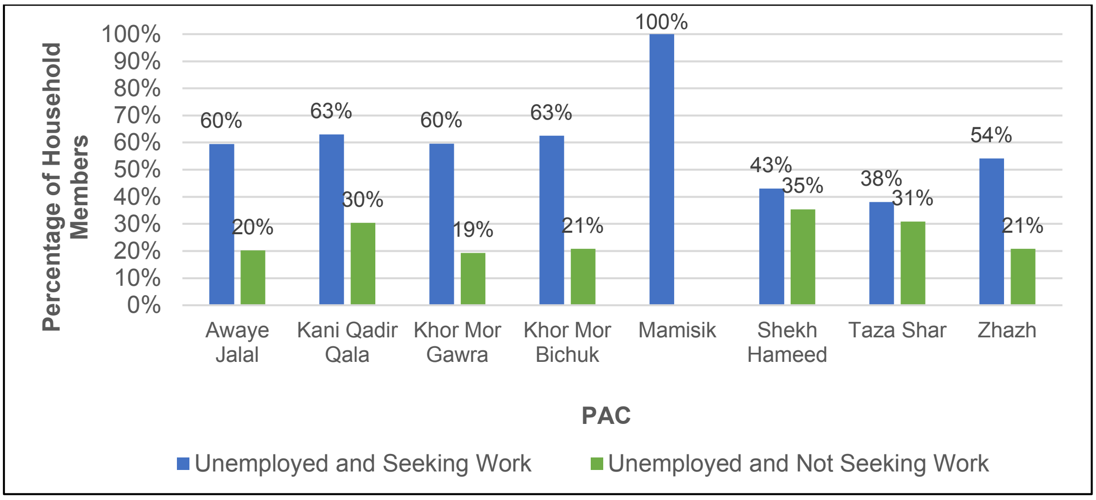


Figure 3-27 Percentage of unemployed household members

Source: Household interviews

Note: Percentages shown exclude those unable to work because age, educational commitments, retirement or disability.

Consistent with data at the regional level, unemployment is an issue which particularly affects female PAC members. No women are employed in Awaye Jalal, Kani Qadir Qala, Taza Shar, Shekh Hameed and Zhazh (FGD with women). A very small number of women are employed as teachers in Khor Mor Gawra and Khor Mor Bichuk (FGD with women). Approximately 95% of female household members reported to be unemployed at the time of the household survey, approximately 46% of whom were seeking work. These figures do not include females who are unable to work because of factors such as age, educational commitments, retirement or disability.

3.4.8 Workers' rights and working practices

Iraq has ratified 68 of the International Labour Organisation (ILO) conventions, including the eight "fundamental conventions", covering subjects that are considered to be fundamental principles and rights at work (ILO, 2019).

At the regional level, the principal legislation governing labour matters in the public and private sector is Labour Law No. 71 of 1987 (Clyde & Co., 2015). In 2015, the federal government issued Labour Law No. 37 to replace the 1987 Labour Law, detailing international requirements and offering protections to all kinds of workers. This law has not yet been legally adopted by the KRP; as a result, the KRI continues to follow the 1987 regulation (Lexology, 2019).

Labour rights are generally not well institutionalised and levels of awareness with regards to labour rights amongst employers and employees in the KRI are low. Employers are legally obliged to provide their employees with a written contract of employment from their first working day. However, a recent study found that only 32% of 1,000 workers sampled had employment contracts, which are a key mechanism through which to protect the rights of workers (Qadr *et al.,* 2016). Those contracts that were in place were sometimes written in Arabic or English only, and not in Kurdish.

All persons employed by Pearl Petroleum (either directly or indirectly through one of its contractors) are provided with an employment contract on their first day of employment. Contracts are provided to Local Nationals[13] in Kurdish; foreign workers' contracts are typically provided in English. Employment contracts are prepared and issued by the Human Resources Department and contain various provisions including (but not limited to) a description of job title and job role, salary and working hours.

The 1987 Labour Law does not oblige employers in the KRI to hire a certain percentage of Iraqi nationals. An exception to this rule is where an Iraqi investment licence is required. In this instance, 50% of the employees must be Iraqi nationals (Amereller, 2014). Foreign workers may not be employed until they acquire a work permit. Employees of branches of foreign companies in the KRI are exempt from this requirement (Amereller, 2014).

The existing facility is subject to a contract with the KRG and does not fall under an Iraqi investment licence. Nevertheless, the employment of Local Nationals over individuals from other parts of Iraq and other countries is strongly encouraged. Local Nationals currently represent over 80% of the workforce at the existing facility, occupying skilled and semi-skilled positions in a wide range of departments. Foreign workers are predominantly expatriates from countries such as the United Kingdom (UK) who fulfil leadership and supervisory positions. Over time, a small number of Local Nationals have progressed into similarly senior roles on site and, in the future, Pearl Petroleum plans to increase this number further.

[13] Local Nationals are defined as persons from the KRI.

The 1987 Labour Law confines routine working periods to a maximum of eight hours per day, six days per week (Amereller, 2018). Additional restrictions are imposed on certain kinds of work, for example work that is performed at night, work that is considered to be arduous or work that is hazardous to human health (Lexology, 2019). Overtime is permitted in exceptional cases, though strictly regulated, and must not exceed 300 hours per year (Amereller, 2018). Workers are entitled to a break of 30 to 60 minutes per day and 20 days of paid holiday per year, with subsequent increases as established by law (Amereller, 2018; Lexology, 2019). Despite such legal provisions, violations of working hours, overtime and holiday leave are reportedly common (Qadr *et al*., 2016). Minimum wages are fixed by the MoLSA and, as of 2018, equate to approximately USD 200 per month (Lexology, 2019).

The working hours of employees at the existing facility are defined in workers' employment contracts. Wage levels are benchmarked by the Human Resources Department against other employers in the industry to ensure alignment with market rates. A proportion of the workforce work on rotation with four weeks on and four weeks off. Operations staff (e.g. technicians, engineers) work shifts of 12 hours per day with work breaks in between. At certain times of year (e.g. during Ramadan and in the summer when temperatures are especially high), the length of the working day and number of work breaks are adjusted to avoid issues such as fatigue and heat exhaustion. Overtime is uncommon and tends to only occur as a result of unplanned events/emergencies.

Discrimination against women in the context of employment is prohibited by national legislation and women are entitled to equal pay and working conditions by law. Nevertheless, as outlined in Section 3.4.11, labour market participation rates for women in the KRI are extremely low. The majority of working women (94%) are employed by the government, working predominantly in sectors such as finance and education. Approximately 1% of working-age women in Kurdistan are employed in the private sector (World Bank, 2016a). The oil and justice sectors are considered to be male dominated (Oxfam, 2018).

Pearl Petroleum's employment policy is to recruit qualified personnel on the basis of their suitability for work, governed by factors such as education, experience, skills and other attributes (CPDG, 2019f). Despite this, no women were working at the existing facility at the time of writing. This may be attributed to several factors, including high levels of illiteracy (see Section 3.4.6.2) and domestic roles and responsibilities. In the future, Pearl Petroleum intends to increase female participation in the workforce, particularly in the Social Performance Department (SPD) through the recruitment of female Social Engagement Officers (SEOs).

At the international level, all nine of the ILO's OHS conventions have been ratified by the KRG (ILO, 2019b). At the regional level, the main legislation governing OHS is the 1987 Labour Law (KRG, 2018).

The number of recorded workplace accidents and deaths across the Kurdistan Region have decreased over time; whereas there were 69 recorded deaths in 2014, only three fatalities were recorded in 2018. It is, however, important to note that statistics surrounding workplace accidents, injuries and fatalities may be underreported, both by employers and employees. In the construction industry, for example, official statistics regarding workplace deaths are reported to be far lower than the reality (Jamal, 2014).

A wide variety of policies and guidelines exist for the purpose of minimising risks to workers at the existing facility, covering topics such as working in adverse weather conditions, working at heights and using power tools. Weekly and monthly departmental safety meetings and regular toolbox talks are another important way of promoting safe and healthy working conditions. In 2018, zero fatalities and lost time injuries (LTIs), three medical treatment/restricted work cases and 26 first aid cases were recorded by Pearl Petroleum on site; a record of zero fatalities has been maintained since 2013 (CPDG, 2018b).

All contractors are required to perform their work in a manner that is consistent with legal requirements and international guidelines governing OHS (CPDG, 2019e). In this context, contractors are further required by Pearl Petroleum to implement a health and safety management system which covers all areas of works (including those performed by any sub-contractors) and submit monthly health and safety reports (CPDG, 2019e). Auditing is an important means through which to monitor contractors' health and safety performance.

The right of all persons to form and join unions and professional associations is legally recognised in the KRI (Qadr *et al*., 2016). The main union federation is the Kurdistan United Workers' Union (KUWU), which organises private sector workers across the following sectors: oil and gas, food and agriculture, services, textiles, transportation, construction and industry. In 2018, a women's committee was established to increase the participation of women in union elections (Qadr *et al.,* 2016; The Militant, 2019). Despite this, only a small proportion of Kurdistan's workforce belong to unions and very few workers participate in union meetings or partake in union activities.

In accordance with regional law and international standards, Pearl Petroleum recognises the rights of workers to freedom of association and peaceful assembly, alongside the right to engage in collective bargaining activities (CPDG, 2019f). Nevertheless, consistent with trends at the regional level, no members of the workforce at the existing facility currently belong to trade unions and no collective bargaining agreements are in place.

Iraq has ratified the key ILO conventions concerning child labour. At the regional level, the KRG has established laws which contain provisions related to child labour, including the 1987 Labour Law, the Ministry of Education Law and the Child Protection Law (DOL, 2017). The minimum working age in the Kurdistan Region is 15, however light work for children aged 13 to 15 years is not explicitly prohibited (Terre des Hommes, 2016). An estimated 6% of children aged between five and 14 years are engaged in child labour in the KRI (UNICEF, 2018a). A child under 18 years of age is not permitted to undertake hazardous work, for example at construction sites or chemical plants.

Access to the existing facility is strictly controlled by security personnel and all persons entering the site are required to have clearance, thereby minimising the risk of child labour occurring within the site boundary. Contractors are required to ensure that statutory requirements regarding child labour are fulfilled (CPDG, 2019e). The auditing of contractors by Pearl Petroleum is an important means of monitoring contractors' social performance and identifying issues such as child labour within the supply chain.

3.4.9 Land

Land use and ownership in the KRI is regulated by a number of laws and legislative acts supported by ongoing land reform and cadastral improvements. The combination of regional laws enacted by KRP and national laws enacted by the federal government contain regulation relevant to land use and ownership.

3.4.9.1 Land use

The KRI covers an area of 46,861.41 km, approximately three quarters of which is agricultural land. Crop land is the main type of agricultural land, accounting for 34.5%; pastureland and forests account for 20% and 15.5% of agricultural land use respectively.

The most common type of land use in the PACs is agricultural land, which is mainly used for crop farming and livestock rearing. At the time of the household survey, 61% of the households interviewed reported having access to arable land. Figure 3-28 presents the percentage of households with access to arable land across the PACs.

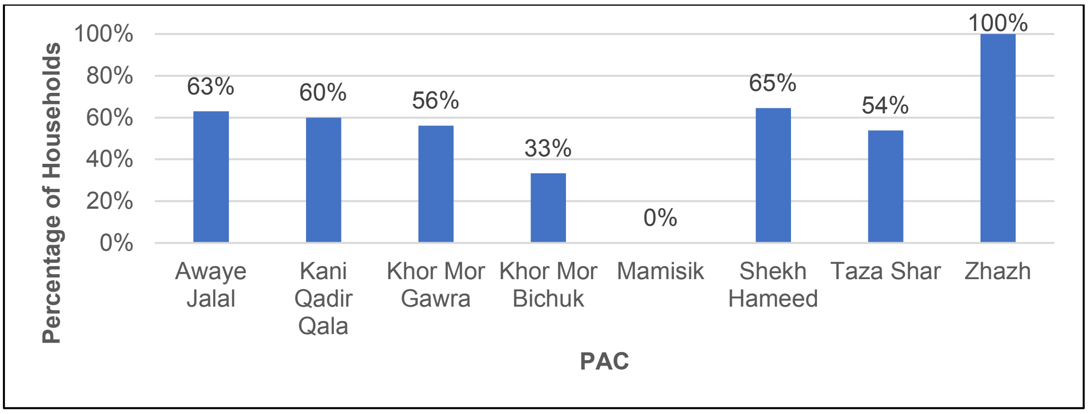


Figure 3-28 Access to arable land amongst households
Source: Household interviews

As shown in Figure 3-28, approximately two thirds of households interviewed in Awaye Jalal, Kani Qadir Qala, Khor Mor Gawra and Shekh Hameed reported using arable land at the time of the household survey. This figure rises to 100% of households in Zhazh and 0% for the household in Mamisik (where there is only one household).

3.4.9.2 Land holdings

The size of landholdings changed as a result of a series of agrarian reforms in the 1970s. These reforms reduced the maximum size of landholdings to between 100 and 1,500 donums (10 and 150 hectares) for irrigated land; non-irrigated land was reduced to between 2,500 and 5,000 donums (250 and 500 hectares). Land holdings above these maximums were often expropriated (Ministry of Planning, 2017). In 1975, an additional reform sought to break up large estates of Kurdish land holders. The expropriation of land during the era of the Baathist regime resulted in the government acquiring large proportions of arable land which, subsequent to its fall, became contested. Whilst the AOI was targeted during the era of the Baathist regime, being particularly affected by the Anfal Campaign of the 1980s, the ownership of the land remained with the original residents (though they were absent from the PACs for a number of years).

The current average landholding size in the KRI is 100 donums (10 hectares). The size of land holdings in the AOI vary. Some land owners were unwilling or unable to disclose the amount of land owned. The largest total land holding claimed by a single household was 425 donums (42.5 hectares); the average land holding was 80 donums (8 hectares).

Household interview data indicates that the majority of households (48%) own or use one plot of land. However, land may also be split into separate parcels to separate crop types. A small proportion of the households interviewed own or use six or seven plots of land (see Figure 3-29). The average number of land plots owned or used by the households interviewed is 2.5.

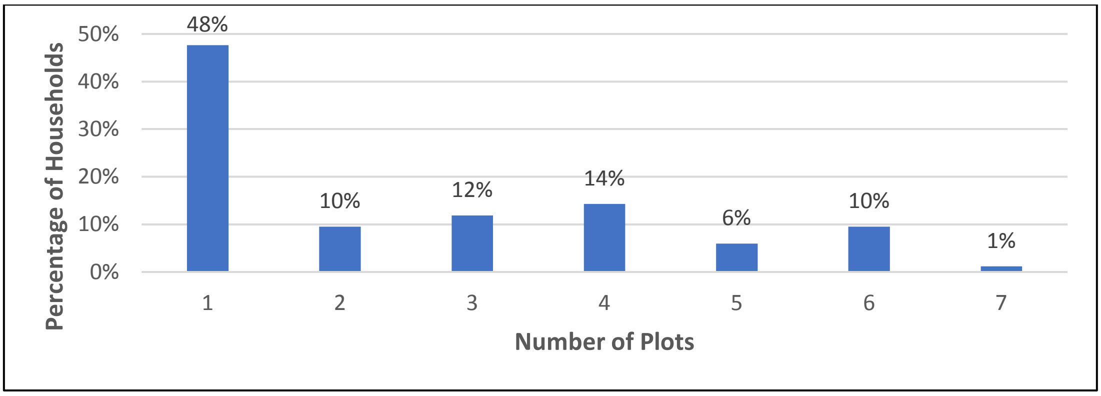


Figure 3-29 Number of plots owned or used by households

Source: Household interviews

3.4.9.3 Land tenure

The following types of land tenure categories are applicable to the KRI:

- private land, whereby the land owner has the right to buy and sell land and to raise capital against the value of the land; this type of land can be owned either by inheriting or by transferring ownership from someone through buying[14]
- public land which is leased by the government on a long-term or short-term basis.

Public land is owned by the KRG and further distinguished according to the following categories:

- rights to use land, which refers to agricultural lands belonging to a person to be used for agricultural purposes; this can be either inherited from parents, bought or sold
- held (ceased) lands, which refers to lands that have been properly held by the owner for a side, group or charity purposes
- disputed lands, which refers to agricultural lands that have not yet been clarified; disputes over the right to use the land are ongoing
- agricultural lands and split decision, which refers to agricultural land rented to farmers by the Ministry of Agriculture for some years under renewable contracts
- rocky and pasture lands, which is sometimes used by farmers for agricultural purposes
- abandoned land, which refers to land belonging to the Ministry of Finance and left to be used for public interest; this type of land is mostly available in urban areas.

[14] This includes inherited land, which has been passed from generation to generation but frequently results in an unmanageable number of owners (USAID, 2019a).

Current data on the distribution of land according to land tenure category is scarce (USAID, 2019a). All land is generally categorised as either urban or rural.

3.4.9.4 *Land ownership*

Though a semi-autonomous region today, Kurdistan's long history as part of Iraq means that it has had numerous land management systems dating back many centuries. Some of these systems have evolved locally across tribes, geographic locations and religions, whereas others have been imposed or imported. The current land ownership system is a set of embedded and overlapping systems which contain many historical elements that can be either contradictory or cooperative, opposed or aligned, applicable only to certain groups and discriminatory to others (Al-Ossmi *et al*., 2015 cited in USAID, 2019a; Stigall, 2009 cited in USAID, 2019a). This can create ambiguity and conflicting claims over land ownership.

The KRG is cognisant of the fact that land ownership issues require attention and need to be resolved, particularly in rural areas. A common problem associated with the confirmation of ownership rights in the KRI is the lack of documentation that attest to land and property ownership, lease, access and use. Therefore, the KRG's Regional Strategic Development Vision for 2020 contains a development goal relevant to land issues, which is aimed at land titling and ownership reforms.

In the AOI, the land ownership situation is predominantly defined by traditional rights where land is inherited through generations. During a large-scale redistribution of landholdings in 1958, land was divided between farmers based on a map approved by the Ministry of Agriculture. The process of land redistribution was stopped in 1963 and the new government declared all land to be owned by the state with individuals being classed as land users. However, those who have some form of documentation issued by the Iraqi government, or who inherited land through the traditional land system, believe they privately own their land. Sometimes they sell the land despite the fact that the ownership rights could be legally challenged.

All of the land owners and approximately 90% of the households interviewed during primary baseline data collection reported that they inherited the land they own and thus possess traditional land rights. Traditional land rights can be inherited by men only, placing women (particularly widows who have also lost their children) in a precarious position with regards to access to land. Interviews with land owners revealed that their family members had lived on the land for the last 100 to 120 years. The majority of land owners, however, do not possess formal documentation (e.g. title deeds) proving their ownership of the land; only 2.6% of households interviewed can prove ownership rights by a title deed or letter of allotment.

Those PAC members who do not hold traditional land rights or titles gain access to land through renting. Persons wishing to cultivate state-owned land obtain usage rights from the Ministry of Agriculture through a formal process. On the other hand, the rental of private land is highly informal and predominantly based on verbal agreements between friends and relatives. Whilst rental fees were not disclosed during interviews and focus groups, participants indicated that rental fees vary depending upon the location, quality and size of the land. In the case of private land, the payment of rental fees may be either in cash or in-kind (e.g. such as sharing harvest). Only 6.1% of the households interviewed during primary baseline data collection reported to be renting land, only 0.4% of whom have signed lease agreements. A profile of the flowline land owners and land users interviewed during primary baseline data collection is presented in Figure 3-30.

Flowline Land Owners and Land Users

A series of KII and FGD with flowline land owners and land users were conducted in October 2019. These activities sought to collect data on:

- land tenure arrangements, land access and ownership
- land-based livelihood activities (crop farming, livestock rearing and natural resource use)
- land-related and livelihood-related conflicts and disputes
- land-owners' and land-users' perceptions towards the Project.

The data were compiled, interpreted and triangulated to develop the socio-economic baseline.

A mixture of land ownership and usage arrangements were described during KII and FGD. The land associated with the flowline land owners is privately owned and was acquired by these individuals through inheritance. This land has typically been owned for over 100 years by the same family, having been passed down through generations. Contrary to trends observed during household interviews, the flowline land owners reportedly possess formal documentation proving their ownership of the land.

Alternatively, the land associated with the flowline land users is eased to these individuals by friends or family or the Ministry of Agriculture. The rental of land from friends or family is highly informal and often based on verbal agreements whereas land which is rented by the Ministry of Agriculture is based on a formal process. Some of the flowline land users reportedly possess formal documentation (e.g. letters from the Ministry of Agriculture) proving their right to use the land whereas others do not.

Land is primarily used for crop farming, with some livestock rearing taking place (mainly sheep, goats and occasionally cows). Natural resources, including wild plants (gundelia and mushroom, grass and berries) are also collected and consumed, or sold for cash income. Land boundaries are typically clearly demarcated by the use of stones or strips of non-cultivated land.

Key challenges for land owners and land users include drought, insufficient water supply and inadequate water quality, attacks on livestock (from wild animals, such as wolves), lack of veterinary services, wildfires and lack of support from government and organisations (e.g. lack of agricultural inputs). Conflicts over land are rare; the few disputes that do occur are mostly related to land demarcations or trespassing by livestock. Conflicts are typically resolved by elders and relatives within a matter of days.

Figure 3-30 Profile of flowline land owners and land users

3.4.9.5 *Access to land*

Land prices in urban areas are high and unaffordable to many. Moreover, fiscal policy related to land use in the KRI imposes a 2% tax on the rental of lands (World Bank, 2016b), which further increases the cost of land itself (Ministry of Planning, 2017). Consequently families increasingly informally occupy public land or agricultural land in peri-urban areas through informal transactions.

According to the World Bank (2016b), there are several constraints to accessing land for private sector investment, including:

- difficulties in clarifying land ownership in rural areas
- difficulties in obtaining land under the jurisdiction of the Ministry of Agriculture and Water Resources (MoAWR) in rural areas
- difficulties in obtaining access near airports owing to security concerns.

Accessing land for construction purposes is challenging because it requires a construction permit, which is obtained through a lengthy and costly process.

3.4.9.6 *Procedure for access to land for oil and gas activities*

In the oil and gas sector, access to land located in rural areas can be obtained with the permission of the KRG Ministry of Natural Resources (MNR), and only for agreed durations (MNR, 2013b). In May 2013, the MNR issued a decree stipulating that companies undertaking exploration and production activities must pay annual rents to owners and/or users on whose land oil well drilling blocks are located. Landowners and/or users and local communities can apply for land-related compensation by completing standard application forms available from the Ministry. An initial committee is established by the District Manager during the pre-acquisition phase, composed of representatives from the district authorities and the Ministry (Directorate) of Agriculture. This committee processes the written request from the company to access land and identifies the land area, coordinates and land owners by undertaking a site visit.

During the actual land acquisition phase, another committee is established by the MNR composed of representatives of the MNR, the Ministry (Directorate) of Agriculture, the Directorate of Real Estate Registration, a land surveyor, local authorities from the district and a company representative. The committee determines the level of crop and land compensation to be paid based on several criteria, including the land area, the type of land, how the land is used, whether it is cultivated, and the previous year’s type of crop as assessed through a survey and land boundary records from the Ministry of Agriculture. The local land office also plays an important role in identifying and certifying the category of the land.

A Higher Committee, formed at the level of the Governorate during the compensation phase, consists of members from the Council of Ministers, the MNR, the Governorate, the Ministry (Directorate) of Agriculture and the Directorate of Real Estate Registration. This committee evaluates the compensation request forms from the affected people and the proposed rates and directs a disbursement request to the MNR. The MNR prepares the agreement to be signed with the land owners and/or users.

Companies are also required to pay annual rents to community members who lose access to the use of public pastures on which drilling blocks are located (MNR, 2013b). Roads used by companies are to be returned to the original users after 50 years.

3.4.9.6.1 Procedure for access to land at the existing facility

In 2007, the KRG signed a Petroleum Development Agreement with Pearl Petroleum to appraise the KM gas field and provide gas supplies for use at power stations in the Kurdistan Region (Pearl Petroleum, 2018). The construction of the existing facility began in 2008; operations began in 2010.

In accordance with the land boundaries defined by the Ministry of Agriculture and the Directorate of Agriculture for Chemchemal, the land that falls within the boundary of the existing facility can be categorised as agricultural, pastoral or rocky land and is divided between households belonging to the following three PACs: Khor Mor Gawra, Khor Mor Bichuk and Awaye Jalal. Through the Directorate of Agriculture for Qadir Karim (the sub-district where the existing facility is based), the affected land parcels in the respective PACs have been verified and supporting cadastral maps have been produced.

In 2011, a ministerial order (No. 7592, dated 02 October 2011) was issued requiring compensation for persons from the above PACs who historically used land within the boundary of the existing facility. None of these persons were living on the land; they were using it for agricultural/pastoral purposes only and thus no physical displacement occurred as a result of the construction of the existing facility. A committee was established in January 2012 to handle the compensation process, comprising representatives from the MNR, the MoAWR, the local government authorities and Pearl Petroleum[15]. The total number of affected land users identified in Khor Mor Gawra, Khor Mor Bichuk and Awaye Jalal were 41, 37 and 17 respectively.

All of the land users were required to provide evidence (e.g. witnesses) proving that they were the proper users of the land. None of the land users claimed ownership rights as none of them possessed documentation (e.g. formal title deeds) proving their ownership of the land, reflecting the situation at the regional level. Only land usage rights were claimed by the land users. Evidence of these rights was provided through the traditional land use arrangements, where the land user raises a claim, supported by two witnesses, with the Anjuman of the village to the related government department. In this context, the related government department was (and remains) the Directorate of Agriculture for Qadir Karim.

All of the users of the land within the boundary of the existing facility have been compensated through the one-off provision of cash compensation. The compensation rate paid was calculated according to market value which, at the time, was approximately one million Iraqi Dinars (IQD) per donum (approximately USD 833). Compensation was paid during two sessions at the MNR (between 22 and 24 January 2011 and on 15 February 2012). The total amount of compensation paid to the 95 land users in the three PACs was IQD 1,896,080,000 (USD 1,580,067).

Upon payment of compensation, each land user signed an agreement with the MNR confirming the following details:

- their full name
- the plot size and location of the land for which they had been compensated
- the amount of compensation paid

[15] These activities were undertaken prior to the publication of more recent ministerial instructions requiring the establishment of three separate committees to handle land-related issues for oil and gas operations in the KRG (see Section 3.4.9.6).

- their understanding and acceptance that:
  - as a result of compensation, they no longer had rights to use the land
  - their compensation was a one-off payment and no additional compensation would be paid
  - the land was now allocated to the MNR for petroleum purposes according to regional law and regulations.

The contents of the agreement were explained orally to land users to confirm their understanding and acceptance of the agreement. Records of each agreement were retained by the MNR and Pearl Petroleum. In line with regional regulatory requirements, a completion audit was undertaken by joint committees, comprising representatives from regional and local government and Pearl Petroleum, to confirm that the affected land users had been compensated in line with the terms of their agreement. Following the completion audit, Pearl Petroleum has remained in contact with the MNR to discuss any related complaints or comments received.

During stakeholder engagement for the ESIA, some of these land users expressed dissatisfaction with the compensation process that was followed, the amount of compensation that they received and the frequency of their compensation payment (one-off rather than yearly). They were advised to report their grievances to Pearl Petroleum's SPD by RSK (through its local in-country partner), using the Community Grievance Management Procedure (see Section 4.6). At the time of writing, however, Pearl Petroleum has not received any related grievances.

In relation to the above concerns, Pearl Petroleum note that the compensation process was:

- implemented in accordance with the regulations of the KRG
- transparent and understandable to all affected persons, with the conditions of compensation payments being clearly stated in supporting documentation (e.g. the compensation agreements between the affected land users and the MNR)
- accepted by the affected land users, who agreed to a one-off compensation payment and understood that no additional compensation would be paid.

Pearl Petroleum further note that the amounts of compensation paid was higher than the amounts that land users typically receive in similar situations across Kurdistan.

Outside the boundary of the existing facility, but within the boundaries of the Khor Mor concession area, there are three well pads (KM3, KM6 and KM9) which are used by Pearl Petroleum but are located on land that has been the property of the government since the 1970s, when it was acquired by the government for oil and gas exploration purposes. According to anecdotal evidence, there is dissatisfaction amongst the former land users/land owners and their descendants, who allege that compensation issues were not properly resolved at the time of acquisition. In addition, there are cases whereby sections of pipeline, connected to the existing facility but located outside the Khor Mor concession area, have allegedly been constructed on land prior to the compensation process (led by the MNR and MoAWR) being finalised.

Such issues are in the process of being addressed by the MNR with a Land Acquisition and Compensation Committee having been established in mid-2019 (with participation from other governmental agencies) to expedite the process.

3.4.9.6.2 Procedure for access to land for the KM250A Project

The process of compensating persons who use land that will be affected by the installation of new flowlines required for the Project is ongoing. The compensation process is being led by the MNR and MoAWR with Pearl Petroleum playing a supporting and facilitating role as appropriate. In line with regional government protocol, a Land Acquisition and Compensation Committee has been formed, consisting of a representative from Pearl Petroleum, alongside other individuals (e.g. representatives from the MNR and local authorities and a land surveyor).

A survey to formally identify the affected land owners/land users has been completed. The survey entailed the collection of data on the boundaries of the affected land (including GIS coordinates), the contact details of the affected land owners/land users and the type(s) of land affected. The preliminary findings of the survey indicate that:

- the types of affected land are agricultural, pastoral and rocky
- no persons are living on the affected land and thus no physical displacement is anticipated (economic displacement only)
- the affected land was not expropriated by the Baathist government historically (see Section 3.4.9.2), though this will be further verified as part of the activities of the Land Acquisition and Compensation Committee.

The resulting documentation from the survey is in the process of being finalised in line with the current Project schedule.

As outlined in Section 6.7.1.4 and Section 6.7.3.2, a series of mitigation measures will be undertaken, including the development and implementation of a Livelihood Restoration Plan (LRP) by Pearl Petroleum, for the purpose of ensuring that affected land users are compensated by the Project in accordance with regional regulations and international standards (specifically IFC Performance Standard 5).

Under IFC Performance Standard 5, a Project which involves economic displacement requires the development of an LRP in order to compensate affected persons and/or communities. As stated in Section 2.5.1, the Project will require land for the construction of up to five additional flowlines external to the boundary of the existing facility. This will result in the economic displacement of affected land owners/land users and therefore an LRP will need to be developed.

The LRP will include:

- a gap analysis of the differences between international standards and regional processes
- principles of land access
- an entitlements matrix based on a mitigation and compensation framework
- details of the valuation of assets and establishment of compensation rates
- the land access procedure
- provisions for vulnerable people
- management of change procedures
- monitoring and evaluation.

3.4.9.7 *Land related conflicts*

Land-related conflict in Iraq and the KRI has a long history originating from successions of invasions and conflicts which have resulted in the major displacement of populations from their lands and properties over time. Waves of internal displacement, resettlement and attempts to reclaim land have been ongoing sources of land conflict (World Bank, 2016b).

According to World Bank (2016b), current land-related conflicts in the country and Kurdistan Region can be categorised as follows:

- conflicts associated with three contemporary periods of large-scale population displacement (the Baathist regime, coalition forces and ISIS conflict)
- the overlap and confusion between land rights for individuals and rights claimed by groups involving ethnic territoriality
- a weak state presence and capacity in large areas of the country, and the filling of this vacuum with tribal, Islamic, militia, and hybrid forms of managing land rights.

Contemporary conflicts concerning land in the KRI typically revolve around land ownership, particularly in rural areas. Lack of documentation, combined with cases of fraud, land confiscations and other factors, have resulted in competing claims over land and property. The issue is particularly contentious in rural areas where land is a vital provisioning ecosystem service and source of income generation for households.

Ongoing debates and parliamentary hearings are currently taking place aimed at addressing ownership disputes that have been illegally appropriated or used in the Kurdistan Region (KRP, 2019). In the AOI, land disputes are known to occur in the PACs over boundary demarcations between neighbours and/or when livestock enter land that is owned by other households.

Left unresolved, such issues may complicate future processes of land acquisition in the AOI in the future. Some PAC members reported that the number of land-related disputes have increased in recent years, owing to an increase in awareness of land rights and different types of land tenure. Land disputes are predominantly resolved by village Anjuman, elders and, where necessary, local government authorities. Disputes and conflicts which cannot be resolved locally are escalated to higher levels, including the courts.

3.4.10 Infrastructure and services

3.4.10.1 *Water and sanitation*

According to UNICEF (2018b), the KRI has made considerable progress in improving access to safe drinking water and sanitation facilities in recent years. The majority of households (90%) are connected to the public water supply network; fewer households (5%) rely on wells (open or closed), water tanks (3%) and surface water sources (e.g. springs, rivers and lakes) (less than 1%) (IOM, 2018a). Rural areas also rely on natural springs, shallow wells and rivers for their water supply (Yousef et al., 2018). In 2018, the International Organisation for Migration (IOM) reported report that most households are now connected to the public sewage network with covered canal (51%) or septic tanks (47%).

Pressure on the region's water resources has been exacerbated by changes in climate. Reduced rainfall and snowfall have resulted in rapidly declining water levels in the KRI, including in springs and shallow wells, particularly in the driest districts of Erbil and Dohuk (IRIS, 2017b). Further threats to water supply in Kurdistan include deteriorating infrastructure as well as upstream water use and damming in neighbouring countries (IRIS, 2017b). An estimated 50% to 60% of distributed drinking water is lost due to leakages or illegal private connections to the grid.

Management of wastewater remains a challenge in the KRI. Except for in the Governorate of Sulaymaniyah, the number of physical facilities (namely wastewater treatment plants and sewerage collection networks) are insufficient (World Bank, 2015). This has led to the discharge of wastewater directly into rivers and other water bodies, thereby increasing public health risks (including outbreaks of water-borne diseases) and environmental pollution. The influx of Syrian refugees and IDPs into Kurdistan in recent years has exacerbated existing pressure on sanitation infrastructure in the region (World Bank, 2015).

Groundwater wells, often connected by pipe to water tanks close to villages, are the main source of water for PAC members. Some of these wells are owned by Pearl Petroleum, whereas others have been drilled by the residents themselves. Surface water is available from streams at certain times of year but many dry up during the dry season and some have dried up permanently. The majority of PACs rely on interior flushing toilets connected to septic tanks or soakaways for sanitation.

Challenges associated with water were consistently reported during primary baseline data collection and included issues with the reliability, quantity and quality of water available in the PACs. Generally, water shortages were reported to be an important community issue. Corroborating data at the regional level, increasing water scarcity was identified as a problem facing crop farmers and stakeholders engaged in livestock rearing (FGD with land users). Furthermore, requests for improved water supply were common during KII with village Anjuman and SDMs.

Conversely, challenges associated with sanitation were not typically reported during primary baseline data collection. Nevertheless, diarrhoea is one of the most common health problems experienced in the PACs (see Section 3.4.5) indicating that sanitation remains an issue in the AOI.

3.4.10.2 Waste disposal

The management of municipal solid waste (MSW) remains an important challenge in the KRI. Approximately 7,500 tons of waste are sent to the region's landfills daily (Rudaw, 2017a). Population growth, economic development and the influx of refugees and IDPs in recent years has increased MSW generation and pressure on existing infrastructure (Aziz *et al*., 2019). According to the World Bank (2015), the additional population produced more than 1,690 tons of solid waste per day in 2015, representing an increase of 26% on the KRI's daily per capita generated solid waste in 2014. Waste management challenges are pronounced in major cities such as Erbil and Sulaymaniyah as a result of urbanisation. Furthermore, hazardous waste disposal facilities in the region are limited and generally do not meet international standards.

In the PACs, the main methods of solid waste disposal as reported during household interviews are presented in Figure 3-31.

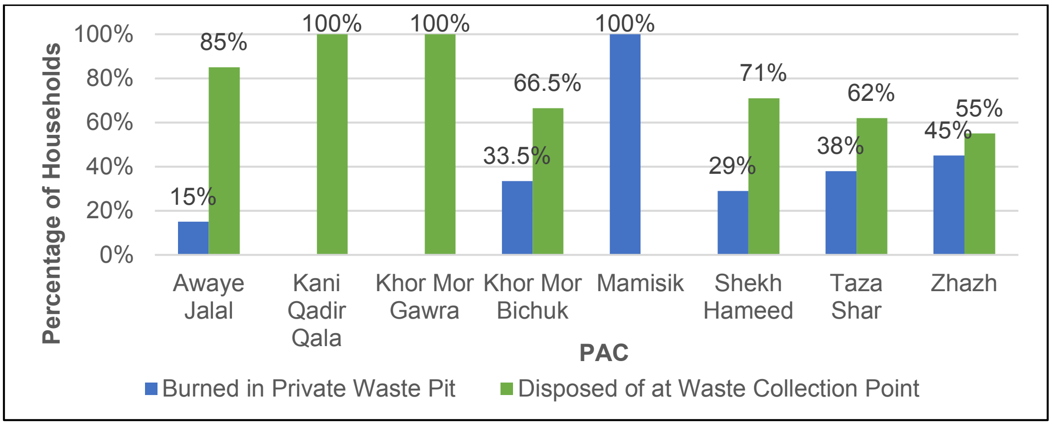


Figure 3-31 Methods of solid waste disposal

Source: Household interviews

Almost all food waste is fed to livestock; some households in Awaye Jalal, Khor Mor Bichuk, Taza Shar and Zhazh burn food waste in private waste pits.

Except for in Mamisik (which consists of only one household), interviewed households mainly dispose of solid waste at waste collection points in the PACs. A private company – Shkar – is contracted by the local government to collect waste from these points weekly; the waste is subsequently burned or deposited in landfills (KII with SDMs). Alternatively, over a quarter of households interviewed in Khor Mor Bichuk, Shekh Hameed, Taza Shar and Zhazh burn solid waste in private waste pits.

Despite a growing interest in recycling at the regional and governorate level, reports of recycling in the PACs were extremely uncommon. During the household interviews, one of the internally displaced families reported that they recycle aluminium. This, however, is to generate income rather than manage waste.

3.4.10.3 Energy

Until 2007, the KRI suffered an acute electricity crisis and an absence of locally generated power; many businesses and residents typically had access to electricity for only two hours a day (PwC, 2018). By 2017, gas supplies accounted for approximately 80% of the energy used for electricity generation in the KRI (PwC, 2018). Though a significant proportion of the electricity generated in Kurdistan is consumed domestically, the region has the greatest electricity access in Iraq, enabling it to supply power to other parts of the country (MNR, 2013a).

The average public electricity supply is limited to 17 hours per day. The number of hours of electricity across the governorates is presented in Figure 3-32.

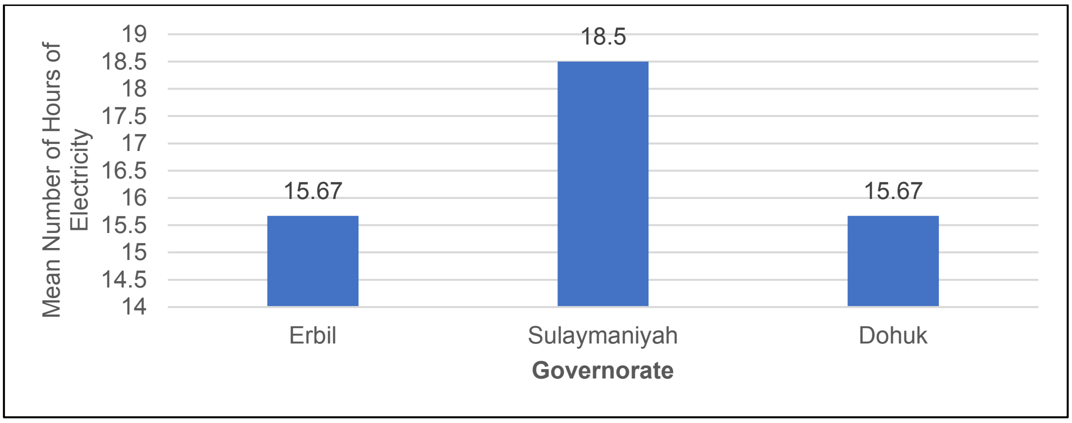


Figure 3-32 Public electricity supply by governorate, 2018 (IOM, 2018a)

Note: No data available on public electricity supply in Halabja.

The availability of electricity fluctuates seasonally as well as spatially; in 2016, for example, parts of Kurdistan lacked power for an average of four hours per day in the spring compared to 13 hours per day in the winter, owing to government-mandated shut-downs (WRI, 2018).

Generators are commonly used in the absence of electricity from the grid. The demographic survey undertaken by the IOM (2018a) found that shared generators are more common in urban areas, whilst private generators are more common in rural areas.

In Sulaymaniyah, households have an average of 19 hours of electricity per day. Approximately 85.5% of households use a shared generator and 0.9% own private generators. Most households use kerosene as their main heating source (96%) and 95% of households use coolers as their main source of cooling (IOM, 2018a).

Electricity is the main source of energy for lighting in the majority of the PACs (KII with village Anjuman and SDMs). Of the 145 households interviewed, 76% rely on electricity provided by Pearl Petroleum; the remainder (24%) derive electricity from private generators. In Zhazh, Pearl Petroleum also provide households with the fuel (diesel) required to run private generators.

Except for private generators, the PACs of Chala Dwana, Mamisik and Qarah Chewar currently have no access to electricity and typically rely on traditional energy sources such as candles and oil lamps for lighting (KII with village Anjuman). Requests for electricity were consistently made during primary baseline data collection in these PACs.

The use of solar power as an energy source is uncommon in the AOI, corroborating data on the limited development of solar power at the regional level.

The main source of energy for cooking is gas (KII with village Anjuman and SDMs). Of the 145 households interviewed, 95% reported using gas cannisters for cooking; a small proportion (4%) use firewood. The use of firewood was also reported by village Anjuman in Cham Surkhaw, Paryawla and Takhta Mina Saru.

Anecdotal evidence suggests that gas cannisters are purchased by households from Qadir Karim and/or from a truck which passes through some of the PACs every two to three days. The cost of gas is considered to be inexpensive with each cannister lasting approximately one month, depending on the size of the household.

3.4.10.4 Housing

The vast majority of people in Kurdistan live in their own houses. Overall, 79% of the population live in households they own and have completely paid for (Ministry of Planning, 2013). This statistic drops slightly in urban areas (to 77%) and increases in rural areas (to 89%).

The demographic survey of the KRI undertaken by the IOM (2018a) found that, in 89% of cases, houses are occupied by a single household, with only 9% of houses accommodating more than one household. Shared housing is more common in urban areas, where families are more likely to share parts of a single house or live in flats (IOM, 2018a). This is driven by higher property and rental prices in urban areas. Despite rapid construction, housing remains in high demand across the region (Ministry of Planning, 2013); housing and rental prices also increased by 20% and 15% in 2018 respectively (Rudaw, 2019). Pressure on the housing market has increased in line with the influx of Syrian refugees and IDPs (see Section 3.4.4).

The majority of households are connected to the public water supply network and most households are connected to the public sewage network. Housing styles and materials vary geographically, reflecting differences in climate and locally available materials (Khoshnaw, 2019). The use of steel and concrete can be observed in major cities such as Erbil; the use of more traditional materials (such as stone, wood and fired bricks) can still be observed in parts of the countryside (Khoshnaw, 2019).

Many houses in the AOI are located within walled/barbed wire compounds and consist mainly of concrete block walls and concrete or iron/tin roofs (see Figure 3-33).

Figure 3-33 Example housing in Khor Mor Gawra

The age of residential structures in the AOI varies. The majority of the 145 households interviewed live in houses which are up to 10 years old (see Figure 3-34). Two exceptions are Khor Mor Gawra and Taza Shar, where approximately half of the households interviewed live in structures that are between 11 and 20 years old.

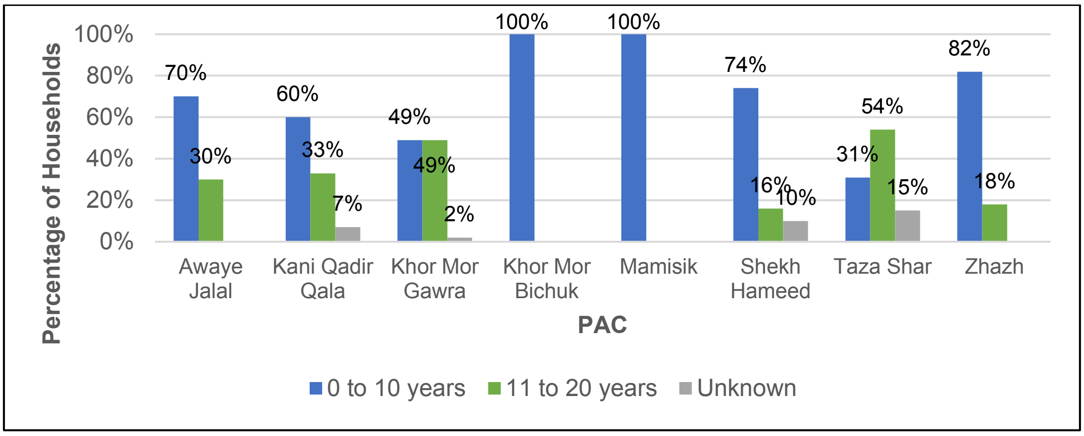


Figure 3-34 Age of household structures

Source: Household interviews

Data gathered during the household interviews indicates that:

- the majority of households interviewed (82%) live in structures comprised of concrete walls; mud and wooden planks are the second and third most common type of material for walls (representing 11% and 1.5% of households respectively)
- the majority of households interviewed (72%) live in structures with concrete rooves; a small proportion (15%) live in structures which have mud roofs
- the majority of households interviewed (83%) live in structures that have concrete floors; ceramic tiles and wooden planks are the second most common material for floors (each representing 4% of households).

3.4.10.5 Transport

3.4.10.5.1 Roads

The KRI has a road network of 23,400 km (World Bank, 2015). This network includes primary roads (linking governorate centres with one another and border crossings), secondary roads (linking areas within districts and sub-districts) and tertiary roads (linking communities in rural areas with one other and with arterial roadways) (Invest in Group, 2013c). The primary and secondary road network is mostly paved, with 52 km being identified as earth, gravel or tracks. Tertiary roads are mostly unpaved and are in poor or very poor condition.

The existing road network in the Project area is the principal means of transporting personnel and equipment to the Project site. There are no buses or public transportation networks available. Generally, most people reported using private cars to go to school, medical centres, shopping and work and 65% of the households interviewed own cars. The road conditions vary significantly from good asphalt paved roads, to high-grade and low-grade gravel roads, down to dirt roads in very poor condition. The main road between Qadir Karam and Khor Mor is considered to be in especially poor condition. Bridge crossings do not identify the load capacity and could represent a safety hazard or heavy loads.

The northern portion of the existing facility is easily accessed by a paved Qadir Karam – Khor Mor - Nojol Road, crossing the Rokhana River through a bridge in Qadir Karam. The southern portion also has easy access by a paved road which runs from Kirkuk along the Imam Qasim Mountain/foothills. Access to the south-eastern part is mainly through low- or high-grade gravel roads from Ibrahim Ghulam, most of which are in poor condition. Access to some areas (especially south-east) is limited by the potential presence of mine fields.

3.4.10.5.2 Traffic

A road traffic and pedestrian count survey was undertaken by RSK in September 2019 in order to understand the existing traffic demand for both light vehicles, heavy vehicles and pedestrians. The surveys were undertaken in the AOI where Project-related traffic during the construction phase is expected to represent a significant increase of traffic on the local public road network. These include main road transportation routes north-east of the site, near the villages of Cham Surkhaw and Qadir Karim, and south-west of the site, near the villages of Khor Mor Gawra and Khor Mor Bichuk. The survey locations are presented in Table 3-34 and illustrated in Figure 2-6 (Section 2.6.1.6).

The traffic count survey (15-minute periods) consisted of:

- manual counting at six strategic locations, north and south directions for each location
- two survey periods:
- morning survey between the hours of 0700 and 1000
- afternoon survey between the hours of 1300 and 1600
- classification of vehicles as motorcycle, car, van, medium goods vehicle (MGV) or heavy goods vehicle (HGV).

Survey results are illustrated in Appendix 2 (Figure A2.1 to A2.6). The busiest periods on the local road network are between the hours of 0800 and 1000, 1400 and 1600.

Table 3-34 Traffic survey locations

Location	Description
Traffic count location 1	Near the village of Zardah, the first entry point into the AOI along the main road transportation route.
Traffic count location 2	After the junction near the village of Cham Surkhaw; this route will then continue towards the site.
Traffic count location 3	Near the junction towards the village of Mamisik.
Traffic count location 4	Near the junction towards the Project site.
Traffic count location 5	Near the junction towards Khor Mor Gawra.
Traffic count location 6	Near the junction towards the villages of Khor Mor Bichuk, Awaye Jalal and Taza Shar.

3.4.10.5.3 Land use along access routes

The land use survey (results in Appendix 2, Figure A2.1 through A2.6) was implemented along the main transportation route to and from the Khor Mor site, and concerned five villages; Zardah village, Ali Mustafa village, Aliawa village, Qadir Karam village and Khor Mor Gawra village along the main transportation route. The survey confirmed the presence of individual housing units, roadside shops, mosques, graveyards, barn houses/livestock pens, fish farms and bridges crossing waterways, including dried waterways. At Qadir Karam village, there is a military checkpoint, oil field police camp and police base nearby.

The land along the public road towards Mamisik village mostly consists of wheat farms and grazing lands for livestock. Other features present along this route include a tanker parking area, abandoned housing units and a military camp. The land surrounding Taza Shar village is used for wheat farming and livestock grazing, and barns are located near the village. There is also a military checkpoint at a bridge crossing a dry waterway at Taza Shar village.

The survey indicated that sensitive receptors within the transport AOI[16] consisted primarily of residential living areas. The access road survey, which was implemented indicated that. Commercial areas and agricultural/grazing support facilities were located beyond 150m from the roads that were the subject of this survey.

3.4.10.5.4 Airports

The KRI is serviced by two international airports, one located in Erbil and one located in Sulaymaniyah. The number of passengers, airport movements and cargo handled by the region's largest airport – Erbil International Airport (EIA) – has shown an overall increase between 2008 and 2018. The construction of a third international airport, located in Dohuk, began in 2012 and, when complete, will handle 328,000 passengers, 8,700 tons of cargo and 3,450 aircraft movements per year (Airport Technology, 2019).

There are no airports in the AOI. The closest airport to the PACs is Sulaymaniyah International Airport (approximately 140 km away).

3.4.11 Community safety, security and welfare

3.4.11.1 Standards of living

The relative security and political stability enjoyed by the region for much of the past two decades has led to positive achievements in the Human Development Index (HDI)[17] of Kurdistan (UNDP, 2014). It now has some of the lowest poverty rates in the country (Vishwanath *et al*., 2015). Figure 3-35 shows the poverty rate for the KRI and the respective governorates (note: no data available on the poverty rate in Halabja).

[16] For all Project phases: 150 m either side of road transport routes where the project's contribution to road transport is expected to be significant.

[17] The HDI is a composite measure of human development which takes into account life expectancy at birth, education and per capita income. The HDI was developed by the United Nations and classifies countries into four tiers of human development: very high, high, medium and low.

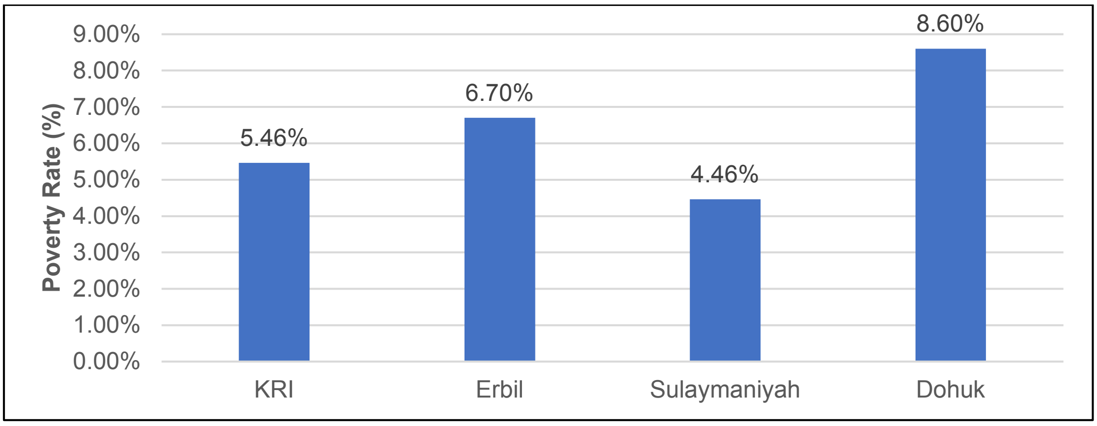


Figure 3-35 Poverty rates in the KRI, 2018 (KRSO, 2019)

Living standards are generally lower in rural parts of Kurdistan, owing to numerous factors such as lower levels of literacy and educational attainment and scarcer opportunities for employment (Harun et al., 2015). With an HDI value of 0.764 and poverty rate of 4.46%, the Governorate of Sulaymaniyah has a higher level of human development and lower level of poverty than other parts of the KRI.

Village Anjuman and SDMs reported a mixture of socio-economic classes within their communities. 50% of population in approximately two thirds of the PACs considered themselves as middle class, having more than one source of income, owning assets (such as land, a car and/or farming equipment) and having ability to hire agricultural labour if needed.

PAC members identified to be lower class was based on their reliance only on one source of income, lack of land and/or other assets and employment as agricultural laborers themselves. The proportion of lower-class PAC members ranges from less than 10% of the population in Ali Mustafa, Awaye Jalal, Chala Dwana and Taza Shar to 80% and above in Khor Mor Gawra and Qadir Karim.

Approximately one third of residents living in Ibrahim Ghulam, Khor Mor Bichuk, Qarah Chewar, Shekh Hameed and Takeya Jabari were identified as belonging to the upper class due to having more than one income source, having their own business or large amount of land and assets to cultivate that land, as well as having ability to hire people to do farming and livestock rearing.

Household interview data indicates that the ownership of consumer goods by PAC members is high, with up to 80% of the households in PACs such as Khor Mor Bichuk and Zhazh owning a car. All interviewed households except for the one household in Mamisik reported to have mobile phones, and every household in Kani Qadir Qala, Khor Mor Gawra, Khor Mor Bichuk, Taza Shar and Zhazh reported to own a television. Up to 75% of households interviewed owned a fridge, increasing to 86%, 88% and 93% in Zhazh, Khor Mor Gawra and Kani Qadir Qala respectively. The ability to afford such items indicates that households enjoy a certain level of disposable income.

Nevertheless, it is important to acknowledge that PACs comprise a mixture of socio-economic classes with a number of poorer households identified by village Anjuman and SDMs, particularly in Cham Surkhaw, Khor Mor Gawra and Qadir Karim. Moreover, demands for improvements in health care, schools, water supply and electricity were consistently made during stakeholder engagement for the ESIA, indicating that community aspirations for higher living standards and a better quality of life are high.

3.4.11.2 Security and safety

The KRI enjoys a higher degree of peace and stability than other parts of Iraq and neighbouring countries and is considered to be relatively secure (OSAC, 2019). Violence in the region has remained low for many years, indicating a high level of internal security not found in the rest of the country (World Bank, 2015). Kurdistan's armed forces, the Peshmerga, play a particularly important role with respect to regional security. Their presence, along with the Asayish officers (local police forces) who come from the PACs, private security personnel and the Oil Field Protection Force at the existing facility, are all contributing factors to relatively high security levels in the AOI. This may play a further role in moderating crime levels.

Risks to the safety and security of PAC members as a result of unexploded ordnance have been pertinent in the past. Victims of land mines were identified during interviews with village Anjuman in Khor Mor Gawra and Khor Mor Bichuk. The sub-district of Qadir Karim (where the Project will be based) has a total of 43 cleared minefields; at the time of writing, the clearance of four minefields is ongoing and nine minefields are still to be cleared. The latter have been marked for safety reasons and are located some distance from the facility and to the south-west of the Project site

Several other threats to public safety remain, including a high level of traffic accidents at regional level, gender-based violence and the widely spread and culturally acceptable ownership of guns. The latter was confirmed during interviews with the village Anjuman and SDMs; men can often be seen walking around carrying guns in Qadir Karim, Takhta Mina Saru and Khor Mor Gawra.

Consistent with data at the regional level, there are low levels of crime in the PACs (FGD with women, KII with village Anjuman and SDMs). This was attributed to a number of factors. The village Anjuman of Khor Mor Gawra stated that because most communities are close knit, often consisting of people either from the local area or who have been in the area for a long time who know one another very well. Despite low levels of crime, risks to the safety and security of PAC members remain.

3.4.11.3 Gender

The United Nation's (UN) Gender Inequality Index (GII)[18] indicates that women in the KRI experience greater equality than women in the remainder of Iraq and other countries in the Middle East (see Table 3-35).

[18] The GII is a composite measure reflecting inequality in achievement between men and women in three dimensions: reproductive health, empowerment and participation in the labour market (UNDP, 2017a). It ranges from zero to one, where the lower the score the more equality there is between men and women (Open Democracy, 2016).

Table 3-35 GII values for the KRI, Iraq and other countries in the region

Country	GII	Global ranking
Iraq	0.506	123
Kurdistan Region	0.410	-
Iran	0.461	109
Syria	0.657	136
Turkey	0.317	69

Source: Open Democracy (2016); UNDP (2017a)

Women in the KRI have more legal rights than women in other parts of the country (Kaya, 2017). The KRG has introduced new legislation and amended existing laws to advance the status of women in society. The Government has also ratified the principles of the Convention on the Elimination of Discrimination against Women (CEDAW) and launched a National Strategy to Confront Violence against Women in 2012.

Notwithstanding these improvements, Kurdish society remains patriarchal and male-dominated (Samad, 2018). As stated in Section 3.4.6, literacy levels and school attendance rates are lower amongst females compared to males (IOM, 2018a). Unemployment rates are 12% higher for women than men, and female labour market participation rates are 50% lower (KRSO, 2019). Household level data is consistent with these findings.

Forced marriage was reported during FGD with women. Participants of focus groups in Khor Mor Bichuk, Khor Mor Gawra and Taza Shar stated that local girls, sometimes as young as 13, are coerced into marrying partners without their agreement.

Vulnerability is defined as a set of specific characteristics that might influence the likelihood of a household of experiencing hardships and result in increased poverty (IOM, 2018b).

3.4.11.3.1 Vulnerable groups

People living with impairments, regardless of their nature, may be particularly vulnerable to material hardship and poverty owing to their dependency on others for support. Approximately 3% of the KRI's population are physically or mentally impaired, representing 2.4% of females and 3.5% of males (IOM, 2018a). The number of persons living with an impairment is also higher in urban areas compared to rural areas (at 3% and 2.5% respectively), and in persons aged 65 years and above compared to persons below the age of 14 (at 18.5% and 1.3% respectively) (IOM, 2018a).

3.4.11.3.2 Elderly or young households

In households where there is a large proportion of young or elderly members, the burden on remaining family members to provide income and support increases significantly.

In approximately 13% of households across the KRI, over two-thirds of members are under the age of 14 or above the age of 65. The overall dependency ratio for the region is 64, lower than the national dependency ratio of 77 (Trading Economics, 2016).

Sulaymaniyah has a lower dependency ratio than Erbil and Dohuk, with 59 dependents per 100 individuals of working age compared to 65 and 69 respectively.

3.4.11.3.3 Female-headed households

Female household heads tend to be less educated and to head smaller, poorer households compared to men. These factors coupled with female inequality in other parts of society increases female-headed households' vulnerability to material hardship and poverty considerably. Approximately 10% of all households in the KRI are headed by females (IOM, 2018a).

3.4.11.3.4 Households facing unemployment

The KRI had an unemployment rate of 9% in 2018 (KRSO, 2019). Amongst the households surveyed by the IOM (2018a), approximately 27% of household heads were unemployed at the time of the survey. Without a stable income or livelihood activity, and in the absence of state support, such households are particularly challenged in terms of their ability to meet their basic human needs and avoid falling into poverty.

3.4.11.3.5 Refugees and internally displaced persons

As outlined in Section 3.4.4, there were an estimated 1.5 million refugees and IDPs in Kurdistan in 2019. A total of 16 internally displaced families were identified across five PACs during household interviews. None of these families owned any land. Three families were experiencing difficulties accessing food. Approximately half of the members of these families were unable to work because of age or disability.

3.4.11.3.6 Children

Whilst the lives of children in the KRI have improved (UNICEF, 2018b), some children remain vulnerable. Access to education and educational attainment is lower amongst children from poorer backgrounds (UNICEF, 2018b), whose families may be unable to afford school-related costs (e.g. transportation, uniforms) or may require them to undertake household tasks (e.g. agricultural and domestic work).

The loss of hundreds of Kurdish Peshmergas during the war against ISIS has also produced a large number of widows and orphaned children, many of whom struggle to access food, water, shelter, health care and education (KSCF, 2014). Some orphans have turned towards child labour to provide for themselves and remaining family members (KSCF, 2014).

3.4.11.3.7 Crop farmers and livestock rearers

Crop farming and livestock rearing are important livelihood activities, particularly in rural parts of Kurdistan. Over the last decade, scientific studies have highlighted the increasing impact of climate change on the region's agricultural sector (see Aziz, 2014; Abdulrahman, 2018). Drought occurrences have posed particular threats to the well-being of crop farming and livestock rearing households; those which are solely dependent on these livelihood activities, and lack alternative sources of income, are particularly vulnerable to material hardship and poverty.

3.4.11.3.8 Elderly widows

Elderly widows, many of whom lost their husbands as a result of the Anfal campaign were reported in Khor Mor Bichuk, Khor Mor Gawra, Zhazh and Kani Qadir Qala. They rely on their relatives, community members and/or government support. Those without relatives, or who are experiencing health problems connected to old age, may be particularly vulnerable.

Key findings on vulnerable groups at the local level are presented in Table 3-36.

Table 3-36 Key findings and analysis of vulnerable groups

Group	Key findings	Analysis of vulnerability
People living with physical and/or mental impairments	Of the 145 households interviewed, a total of 10 households (approximately 7%) have at least one family member living with a disability. People living with a mental and/or physical impairments were also identified in Cham Surkhaw, Paryawla and Takhta Mina Saru. Types of impairment include mental illness, blindness, deafness and physical disabilities (resulting from land mines).	People living with physical and/or mental impairments have the potential to be vulnerable as they may struggle to find employment, or undertake livelihood activities and, as such, may not have the capacity to provide for themselves, leading to a reliance on relatives, community members and/or the government for income and support. Those living without relatives may be particularly vulnerable. People living with physical and/or mental impairments may also be subject to discrimination or marginalisation in the workplace or community. Differential treatment and/or exclusion in these settings may lead to social isolation and reinforce the vulnerability of this group. Discrimination may also lead to poorer access to physical health care, thereby exacerbating the health problems experienced by this group.
Elderly or young households	Of the 145 households interviewed, a total of 136 households (93%) had at least one family member that was classed as being too old or young to work at the time of the household survey. The burden of elderly and/or young persons on working family members was not reported to be an issue.	Not considered to be vulnerable except for households which have a significant proportion of young or elderly members. In these households, there may only be one or two members of working age, leading to lower income levels relative to other households, difficulties in meeting basic needs (e.g. food) and increasing the risk of children dropping out of school to engage in child labour. Households with a significant proportion of young or elderly members, who do not have diversified livelihood strategies, may be particularly vulnerable.
Female-headed households	Of the 145 households interviewed, a total of 10 household heads (1%) were female-headed.	Likely to be vulnerable owing to high levels of female unemployment and illiteracy and lack of assets (e.g. land) and limited role in community decision-making.

Group	Key findings	Analysis of vulnerability
Households facing unemployment	Approximately 80% of household members of working age reported to be unemployed at the time of the household survey. Challenges typically associated with unemployment (e.g. access to food, education and health care) were not reported to be issues. In the absence of employment, PAC members rely on other income-generating activities (IGAs) (e.g. crop farming, livestock rearing) to survive.	Not considered to be vulnerable except for households facing unemployment who also lack alternative sources of income.
IDPs	Total of 16 internally displaced families identified across five PACs during household interviews. None of these families own land. Three of these families experience difficulties accessing food, representing half of all households who reported that food security was an issue at the time of the household survey. The majority of the members of these families (96%) have no education or did not complete primary school; only 2% completed primary school and only 1% completed secondary school. Approximately half of the members of these families are unable to work because they are either too young, too old or have a disability[19]; the remaining half were unemployed at the time of the household survey. Internally displaced families were further identified in Ali Mustafa and Chala Dwana, working as shepherds on low incomes. No refugees were identified in the AOI during primary baseline data collection.	Likely to be vulnerable owing to lack of assets (e.g. land), food (in the case of some families), low levels of education and high unemployment. The primary data indicates that communities have been benevolent towards IDPs in the PACs, which may help to reduce their vulnerability to an extent.

[19] Only one internally displaced household reported that they had a member who was living with a disability.

Group	Key findings	Analysis of vulnerability
Children	Children from poor economic backgrounds are attending schools in Khor Mor Gawra, Shekh Hameed, Qadir Karim and Takeya Jabari. One or more orphans are living in the following PACs: Shekh Hameed, Zhazh, Qadir Karim, Takeya Jabari, Awaye Jalal, Ibrahim Ghulam and Paryawla. Orphans in many of the PACs are reported to be well cared for by relatives. No child-headed households were identified during household interviews.	As a general group, children are likely to be vulnerable to injuries associated with road traffic accidents and construction sites as they tend to have a poorer sense of road safety and be less risk averse compared to adults. Children with disabilities have the potential to be vulnerable as they may experience discrimination and marginalisation at school and/or in the local community Children from poor economic backgrounds are likely to be vulnerable given the limited ability of low-income families to meet their basic needs (e.g. food) and educational needs (e.g. transportation, clothing, stationary). They may also be required to contribute to household tasks (e.g. livestock rearing), leading to poor school attendance and increasing the risk of children dropping out of school altogether. Depending upon circumstance, orphans have the potential to be vulnerable. Whilst many were reported to be supported by family members (e.g. uncles), some of these people are on low incomes and struggle to meet the basic needs of themselves and their families. Whilst no child-headed households were identified in the PACs during primary baseline data collection, there is the potential for orphaned children to become heads of households, acting as primary caregivers for younger siblings.
Crop farmers and livestock rearers	Crop farmers and livestock rearers are faced with drought and water scarcity, amongst other challenges related to their livelihoods. These PAC members were not identified to be vulnerable, owing to the fact that crop farming and livestock rearing is often combined with other IGAs. Livestock rearers in Ali Mustafa and Chala Dwana come from families which have been internally displaced by the ISIS conflict.	Not considered to be vulnerable except for those who lack alternative IGAs or are hired to do crop farming or livestock rearing; hired agricultural labour in the PACs typically have only one source of income and earn low wages. Livestock rearers from internally displaced households are likely to be vulnerable given the additional challenges typically faced by these households in terms of lack of assets and low levels of education.

Group	Key findings	Analysis of vulnerability
Elderly widows	Elderly widows who lost their husbands as a result of the Anfal campaign were reported in Khor Mor Bichuk, Khor Mor Gawra, Zhazh and Kani Qadir Qala.	Elderly widows have the potential to be vulnerable as they may experience difficulties in undertaking livelihood activities due to declining fitness and health, thereby constraining their ability to provide for themselves, leading to a reliance on relatives, community members and/or the government for income and support. Those living without relatives may be particularly vulnerable.

3.4.12 Cultural heritage and archaeology

3.4.12.1 Tangible cultural heritage

The KRI is recognised as possessing significant cultural heritage including many important prehistoric archaeological sites. However, the archaeological potential of the region remains widely unknown (MapCom, 2018). The study area has some sensitive cultural heritage receptors in the form of cemeteries, some of which appear to be very old and related to settlements which are no longer present.

During the Saddam Hussein era, the Kurds within Iraq were persecuted, ethnic cleansing was reported, and during the years 1986 – 1989 the al Anfal campaign aimed to destroy Kurdish ethnicity within Iraq. As a result, whole villages were forced to relocate, with the entire villages being destroyed. This was evidenced during a previous site visit by ERM in 2015, conducted as part of an environmental impact assessment for the existing Khor Mor gas plant construction, with a number of destroyed villages observed. The rubble from the villages appears to be undisturbed, acting as a form of permanent memorial and reminder of the campaign (ERM, 2015). During the MapCom field survey (2018) and interviews with local residents, some sites were considered important sites of archaeology, such as an old mosque (200 years old) in Shekh Hameed village and old remains of Girdi Awaye in Awaye Jalal.

A number of small graveyards are present in the AOI at the following villages:

- Ali Mustafa
- Qarah Chewar
- Aliawa
- Shekh Hameed

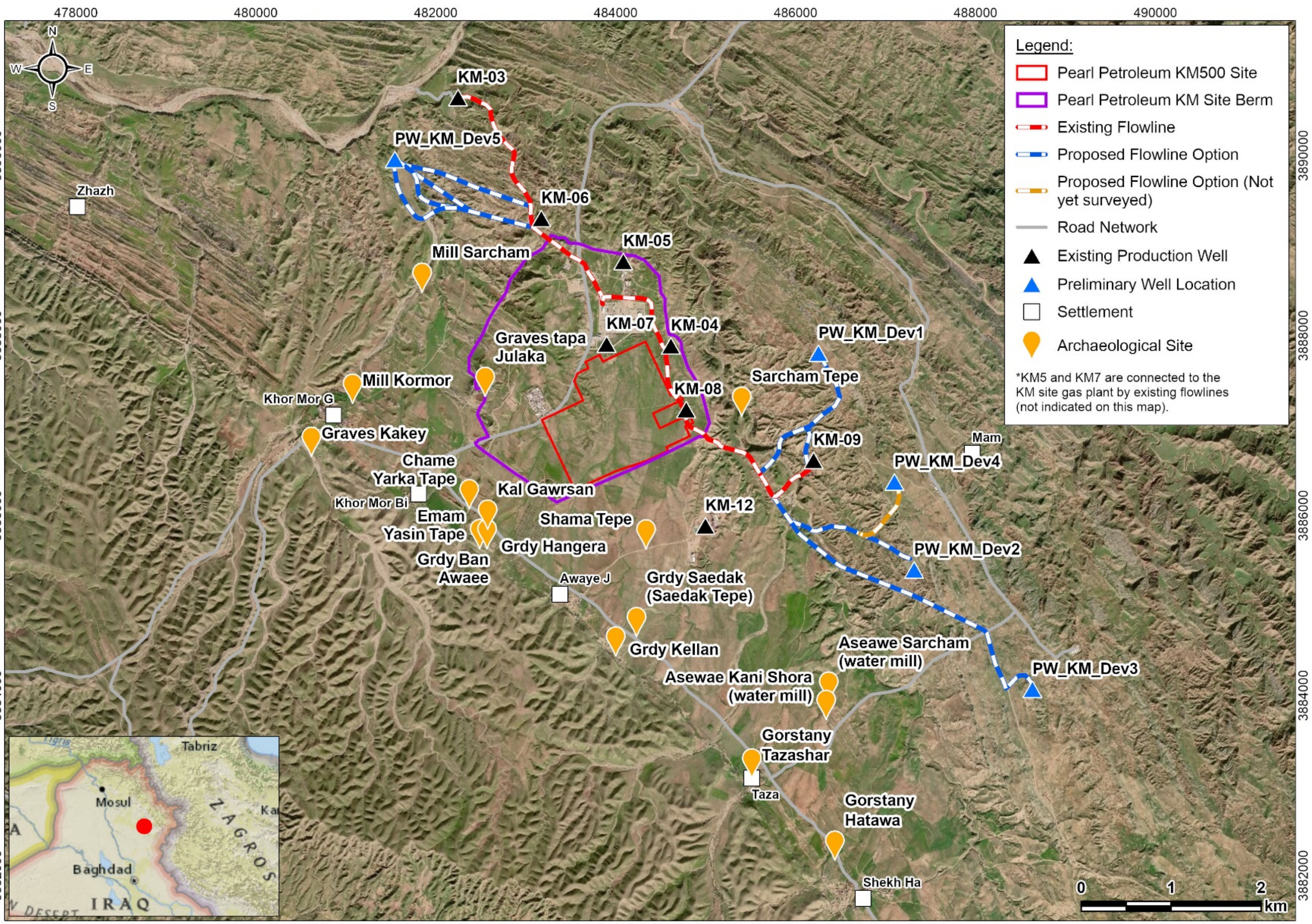
Other notable sites include:

- An ancient memorial cemetery is situated 2 km from Zhazh village. It has been visited by archaeologists and has been registered as a place of cultural heritage.
- Qarah Chewar shrine (aka Shekh Hassan Qarah Chewar Marqad), at Qarah Chewar village, is approximately two centuries old and contains graves of famous Islamic men (sheikhs). It is frequently visited by those practicing their religion.
- Kharaba Kona, at Takhta Mina Saru village, contains ancient relics made of clay and rock. It is visited by archaeologists but is off limits to tourists.
- Qshlagh place, at Ibrahim Ghulam village, is an ancient place of community gatherings.
- Mosques were observed during the land use survey (Appendix 2, Table A2.3 and A2.4) at Qarah Chewar and Aliawa village. It is likely that other mosques are located in the AOI.

3.4.12.2 Archaeology

An archaeology survey was conducted in November 2019 by an archaeologist from the Directorate of Antiquities of the Garmiyan Region. There are various identified archaeological sites surrounding the main Project site (see Figure 3-36 and Appendix 2). Only one, Sarcham Tepe (see Figure 3-37), is located near a KM25A Project construction site, concerning the proposed flowlines. The site is a hill with rectangle shape with approximate dimensions of 20 m by 30 m. Sarcham Tepe is thought to date from the Sassanid period (226-637 AD). The site is approximately 5 m higher than the surrounding flat area. The proposed flowline is not expected to disturb the site, although possible movement of flowline locations following additional surveys could bring flowline construction activities closer to the site. According to the Directorate of Antiquities, the Sarcham Tepe grave site is not threatened.

The Tapa Julaka grave site (Ottoman 1500 to 1918 AD) is located adjacent to the berm to the west of the KM site. The rectangular site is approximately 150 m by 100 m and approximately 1 m higher than the surrounding flat area. There are no on-going activities associated with KM250A Project or the existing gas plant in the vicinity of the Tape Julaka grave site. According to the Directorate of Antiquities, the Tapa Julaka grave site is not threatened.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
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Figure 3-36 Archaeological sites in the general Project area

Figure 3-37 View of the area of Sarcham Tepe (left) and Tape Julaka (right) archaeological sites

3.4.12.3 Intangible cultural heritage

There are many festivals in the AOI, affiliated with the various tribal groups. The celebrations begin following the improvement in weather conditions (autumn) and are mainly based around food, socialising and sometimes music. Often the different tribes will attend one another's festival celebrations.

The tribal festivals celebrated within the AOI include Shekhan Festival, Zanga Festival and Jabari Festival. The tribes' leaders will organise the events in either March or April, however these festivals do not occur regularly every year.

During these festivals, the tribes people partake in singing and dancing around bonfires, feasting, horse riding and wearing traditional clothes. During the Shekhan Festival, there are also readings of the village history and photos of the dead are shown in appreciation.

Kurdish New Year, also known as Newroz, is celebrated in March and, similar to tribal celebrations, is based on eating together and socialising. Wedding celebrations often last three days and residents from other villages often join in on the celebrations of feasting and dancing (Khor Mor Gawra).

3.5 Ecosystems services

IFC PS6 defines ecosystem services as 'the benefits that people, including businesses, derive from ecosystems.' PS6 organises ecosystem services into four types:

i. provisioning services, which are the products people obtain from ecosystems
ii. regulating services, which are the benefits people obtain from the regulation of ecosystem processes
iii. cultural services, which are the nonmaterial benefits people obtain from ecosystems
iv. supporting services, which are the natural processes that maintain the other services.

Key findings on ecosystem services in the Project socio-economic AOI (Figure 3-16) are provided in the following sections.

3.5.1 Provisioning services

Key provisioning services within the Project socio-economic AOI are as follows:

- Rainwater is a vital provisioning service for households engaged in crop farming (see Section 3.4.7.3). Almost half of the households interviewed in the AOI rely on crop farming for income generation and subsistence. Consistent with data at the regional level, the production of crops like wheat and barley in the AOI is predominantly rain-fed; the use of irrigation is limited. The baseline data revealed an increase in challenges surrounding rainwater (e.g. drought periods) in recent years, with negative outcomes for crop farming.
- Freshwater is a vital provisioning service for all of the PACs (see Section 3.4.10.1). PAC members rely on a combination of groundwater and surface water sources for drinking, domestic purposes (for example cooking, cleaning), livestock rearing and (in some cases) irrigation. Groundwater, extracted from Pearl Petroleum- and community-owned wells, is particularly important for drinking and livestock rearing. Streams, ponds and seasonal springs are relied upon to a lesser extent. Access to freshwater is essential to household incomes and livelihoods, health and well-being. Challenges with regards to water quality, quantity and reliability were widely reported during social baseline data collection. FGD with land owners and land users indicated that levels of groundwater in the AOI are declining.
- Land is a vital provisioning service for all of the PACs, providing the fundamental resources (e.g. soils, water, pasture) on which key local livelihood activities such as crop farming and livestock rearing depend (see Section 3.4.9). Given the scarcity of alternative income-generating activities (e.g. formal employment), the importance of land is particularly high relative to other parts of the region. Some households in the PACs further rely on land for the purpose of harvesting natural resources such as wild foods (e.g. berries, nuts, mushrooms) and wild plants/grasses. Wild foods were not, however, reported to be a major food source relative to other food sources. Wild plants and grasses are an important source of fodder for livestock, though households typically have a certain degree of disposable income and also secure livestock feed from locations outside of the AOI. Two regional wheat cultivars (*Triticum aestivum* and *Triticum durum* are known in the Chemchemal area (Section 3.3.5.4).

Very little information is available on the local use of cattle, sheep and other grazing animals (for example for meat, skins, etc.).

The following provisioning services were identified, but are considered to be of minor importance to PAC members relative to rainwater, freshwater and land:

- Construction materials: approximately one fifth of the households interviewed gather local aggregates (e.g. stone) for residential construction purposes whilst approximately one third of the households interviewed gather wood and mud to construct residential buildings and/or livestock enclosures/shelters. However, households typically have a certain degree of disposable income and secure construction materials from outsides outside of the AOI.
- Medicinal plants: contrary to data at the regional level, the harvesting of wild plants for medicinal purposes is uncommon in the AOI, with few households relying on traditional medicine to treat health problems.
- Wild animals: the hunting of species such as eagles and gazelles is uncommon in the PACs, particularly compared to in the past, owing to legal restrictions imposed by the KRG. None of the households interviewed reported relying on wild animals for income generation and other purposes (e.g. subsistence).
- Fish: the capture of wild and reared fish is not a common livelihood activity in the AOI, owing to issues with water scarcity. Aquaculture is undertaken in a small number of PACs but was not identified to be an important source of income and major source of subsistence.

- Firewood: the use of firewood was reported by a small proportion of households (4%) interviewed but the vast majority rely on gas cannisters for cooking (this reflects the sparse presence of firewood in the general Project area).

3.5.2 Regulating services

The lack of forests or vegetative cover in the Project area limits the range of regulating services (including carbon absorption, erosion control, soil retention and retention of water). As per Section 3.2.3.2, in the valleys and river embankments within the Project area the soil is mainly alluvium consisting of gravel and sand. This facilitates groundwater recharge (a regulating service).

The presence of bats in the area regulates exposure of crop and livestock to pests and disease.

3.5.3 Cultural services

Stakeholder engagement has not indicated any cultural services provided by ecosystems within the Project socio-economic AOI.

3.5.4 Supporting services

Water cycling occurs on a limited basis within the Project area, due to the limited presence of perennial rivers and streams.

4 STAKEHOLDER ENGAGEMENT

4.1 Introduction

In October 2019, a Stakeholder Engagement Plan (SEP, RSK, 2019) was compiled for the environmental and social impact assessment (ESIA). This section describes how stakeholder engagement activities have been undertaken since the beginning of the ESIA and outlines how stakeholder engagement will be continued following the completion of the ESIA. This chapter includes:

- objectives of the stakeholder engagement
- stakeholder identification and analysis
- details of the activities undertaken
- an analysis of stakeholder issues and concerns raised
- the Grievance Management Procedure
- ongoing engagement activities.

This chapter will be updated with the outcomes of the ESIA public disclosure prior to the final submission of the ESIA.

4.2 Objectives of the stakeholder engagement

The objectives of stakeholder engagement during the ESIA are to:

- inform stakeholders in an accessible and appropriate manner about the Project and the ESIA, opportunities for them to engage, and the Project grievance mechanism
- ensure that stakeholders understand how they might be affected by the Project and their potential role in impact identification and management
- obtain the input of stakeholders into Project impact identification and impact management
- provide opportunities for stakeholders to express their opinions and concerns about the Project and the ESIA, and ensure that these opinions and concerns are considered in the ESIA and any related management decisions
- during public disclosure, to provide feedback to, and hear comments from, the stakeholders on the impact assessment and associated management or mitigation measures.

4.3 Stakeholder identification and analysis

4.3.1 Stakeholder identification

Stakeholders are defined as persons or groups external to a project's core operations that may be affected by the project, have an interest in it or have influence over it.

Stakeholders were identified based on:

- Pearl Petroleum staff and contractors' general knowledge of the area
- site visits conducted by Pearl Petroleum staff and contractors (including the ESIA consultants)
- the ESIA consultants' general knowledge of the area and previous experience conducting ESIA in Kurdistan

- desktop research
- an understanding of the preliminary potential impacts of the Project and the area of influence (AOI, Figure 3-16) in which these are expected to occur
- the snowballing effect, where encountered stakeholders identify additional stakeholders.

The process for stakeholder identification is dynamic and an ongoing process throughout the ESIA.

4.3.2 Scoping phase

4.3.2.1 Stakeholder analysis

Project stakeholders were identified based on a methodology that was set out for stakeholder analysis. The methodology analyses the:

- level of influence that stakeholders have on the project, rated as low, medium or high
- level of impact that the Project has on stakeholders, rated as low, medium or high.

Stakeholders were identified and grouped into categories. Table 4-1 shows the stakeholder level of influence and level of impact. Once the analysis was completed, the mapping of each stakeholder was undertaken. Detailed mapping can be found in Figure 4-1 below. Table 4-1 also refers to the labels for which Figure 4-1 was mapped.

Table 4-1 Project level of influence and impact on the Project

Stakeholder name and category	Level of influence	Level of impact	Label for stakeholder mapping
Regional government			
Ministry of Natural Resources (MNR) (including the MNR Representative for the Governorate of Sulaymaniyah)	**High**- Administers all operations regarding the petroleum industry in the Kurdistan Region of Iraq (KRI) Actively involved in the review and approval of ESIA studies for the petroleum industry – ability to facilitate or block Project	**Low**- Potential contribution of the Project to the long-term development goals of the MNR	**1**
Ministry of Agriculture and Water Resources	**Medium**- Can provide information (e.g. regarding local land owners) Can damage/boost reputation	**Low**- Potential disturbances to agricultural land and water by the Project	**2**
Board of Environment	**Medium**- Can provide information (e.g. on environmental conditions and concerns in the Governorate of Sulaymaniyah and the Khor Mor area) Can damage/boost reputation	**Low**- Potential for the Project to lead to environmental impacts	**3**
Minister of Housing and Reconstruction (including the Department of Roads)	**Medium**- Can damage/boost reputation	**Low**- Potential for the Project to affect public infrastructure (e.g. particularly roads and bridges)	**4**
Minister of Martyrs and Anfal Affairs	**Medium**- Can provide information (e.g. on history of Anfal in Khor Mor area, people affected by Anfal) Can damage/boost reputation	**Low**- Potential for the Project to have disproportionate impacts on people affected by Anfal (a potentially vulnerable group)	**5**
Mine Action Agency	**Medium**- Can provide information (e.g. regarding unexploded ordinance that may be disturbed by the Project) Can damage/boost reputation	**Low**- Potential for the Project to disturb unexploded ordinance in Khor Mor block	**6**

Stakeholder name and category	Level of influence	Level of impact	Label for stakeholder mapping
District government			
District Manager (Mayor) of Chemchemal	**High**- Can provide information Can damage/boost reputation Can facilitate the Project and Project-related activities (e.g. ESIA studies) Important role in decision-making at the district level	**Low**- Potential for the Project to lead to environmental and/or socio-economic changes within their jurisdiction	**7**
Sub-district government			
Sub-District Manager (SDM) (Mayor) of Qadir Karim	**High**- Can provide information Can damage/boost reputation Can facilitate the Project and provide support (e.g. if/when issues concerning the communities arise) Must give consent before Project-related activities (e.g. ESIA studies) can be undertaken within their jurisdiction	**Medium**- Potential for the Project to lead to environmental and/or socio-economic changes within their jurisdiction	**8**
SDM (Mayor) of Takeya Jabari	**High**- Can provide information Can damage/boost reputation Can facilitate the Project and provide support (e.g. if/when issues concerning the communities arise) Must give consent before Project-related activities (e.g. ESIA studies) can be undertaken within their jurisdiction	**Medium**- Potential for the Project to lead to environmental and/or socio-economic changes within their jurisdiction	**9**

Stakeholder name and category	Level of influence	Level of impact	Label for stakeholder mapping
Local leadership (village Anjuman)			
Village Anjuman of Zhazh, Khor Mor Gawra, Khor Mor Bichuk, Awaye Jalal, Taza Shar, Shekh Hameed, Kani Qadir Qala and Mamisik	**High**- Can facilitate the Project and provide support (e.g. if/when issues concerning the village arise) Can spread positive/negative publicity about the Project amongst community Can exert strong influence over community members and their perceptions of the Project Can provide information (e.g. for ESIA studies) The direct link between the Project-affected community (PAC) and the existing facility/Project	**High**- Potential for the Project to generate benefits, lead to environmental and/or social changes within their community Close proximity to Project	**10**
Village Anjuman of Chala Dwana, Aziz Bag, Takhta Mina Saru, Ibrahim Ghulam, Cham Surkhaw, Aliawa, Qarah Chewar, Ali Mustafa and Paryawla	**High**- Can facilitate the Project and provide support (e.g. if/when issues concerning the village arise) Can spread positive/negative publicity about the Project amongst community Can exert strong influence over community members and their perceptions of the Project Can provide information (e.g. for ESIA studies) The direct link between the PAC and the existing facility/Project	**Medium**- Potential Project-related benefits Potential impact of Project upon community members	**11**

Stakeholder name and category	Level of influence	Level of impact	Label for stakeholder mapping
PACs (including men and women and flowline land owners and land users affected by the Project)			
Zhazh, Khor Mor Gawra, Khor Mor Bichuk, Awaye Jalal, Taza Shar, Shekh Hameed, Kani Qadir Qala and Mamisik	**Medium**- Support for or resistance to the Project Can provide information (e.g. for ESIA studies)	**High**- Potential Project-related benefits Potential impact of Project upon community members Close proximity to Project	**10**
Chala Dwana, Aziz Bag, Takhta Mina Saru, Ibrahim Ghulam, Cham Surkhaw, Aliawa, Qarah Chewar, Ali Mustafa, Paryawla, Qadir Karim and Takeya Jabari	**Medium**- Support for or resistance to the Project Can provide information (e.g. for ESIA studies)	**Medium**- Potential Project-related benefits Potential impact of Project upon community members	**11**
Qadir Karim and Takeya Jabari	**Medium**- Support for or resistance to the Project Can provide information (e.g. for ESIA studies)	**Medium**- Potential Project-related benefits Potential impact of Project upon community members	**12**
Flowline land owners and land users affected by the Project	**Medium**- Can facilitate the Project Support for or resistance to the Project Can provide information (e.g. for ESIA studies)	**High**- Potential impact of Project upon land-based livelihood activities of flowline land owners and land users	**13**
Civil society			
Organisation for Protecting the Environment	**Medium**- Can spread positive/negative publicity about the Project Can provide information (e.g. for ESIA studies)	**Low**- Potential impact of Project on issues targeted by non-governmental organisations (NGOs) (e.g. environmental)	**14**
Jiyan Foundation for Human Rights	**Medium**- Can spread positive/negative publicity about the Project Can provide information (e.g. for ESIA studies)	**Low**- Potential impact of Project on groups targeted by NGO (e.g. women, children, disabled persons)	**15**

Stakeholder name and category	Level of influence	Level of impact	Label for stakeholder mapping
Local social services			
Qadir Karim Medical Centre	**Low**- Support for or resistance to the Project Can provide information (e.g. for ESIA studies, particularly in relation to vulnerable groups)	**Medium**- Potential impact of Project on demand for their services	**16**
Qadir Karim Primary and Secondary School	**Low**- Support for or resistance to the Project Can provide information (e.g. for ESIA studies, particularly in relation to vulnerable groups)	**Medium**- Potential impact of Project on demand for their services	**17**
Takeya Jabari Health Care Centre	**Low**- Support for or resistance to the Project Can provide information (e.g. for ESIA studies, particularly in relation to vulnerable groups)	**Medium**- Potential impact of Project on demand for their services	**18**
Takeya Jabari Primary School	**Low**- Support for or resistance to the Project Can provide information (e.g. for ESIA studies, particularly in relation to vulnerable groups)	**Medium**- Potential impact of Project on demand for their services	**19**
Shekh Hameed Primary School	**Low**- Support for or resistance to the Project Low- Can provide information (e.g. for ESIA studies, particularly in relation to vulnerable groups)	**Medium**- Potential impact of Project on demand for their services	**20**
Kani Qadir Kala Primary School	**Low**- Support for or resistance to the Project Can provide information (e.g. for ESIA studies, particularly in relation to vulnerable groups)	**Medium**- Potential impact of Project on demand for their services	**21**
Khor Mor Gawra Primary School	**Low**- Support for or resistance to the Project Can provide information (e.g. for ESIA studies, particularly in relation to vulnerable groups)	**Medium**- Potential impact of Project on demand for their services	**22**

Stakeholder name and category	Level of influence	Level of impact	Label for stakeholder mapping
Educational institutions and academia			
University of Sulaymaniyah	**Low**- Support for or resistance to the Project Can provide information (e.g. for ESIA studies)	**Low**- Potential for the Project to generate employment and training opportunities for graduates	**23**
Charmo University	**Low**- Support for or resistance to the Project Can provide information (e.g. for ESIA studies)	**Low**- Potential for the Project to generate employment and training opportunities for graduates	**24**

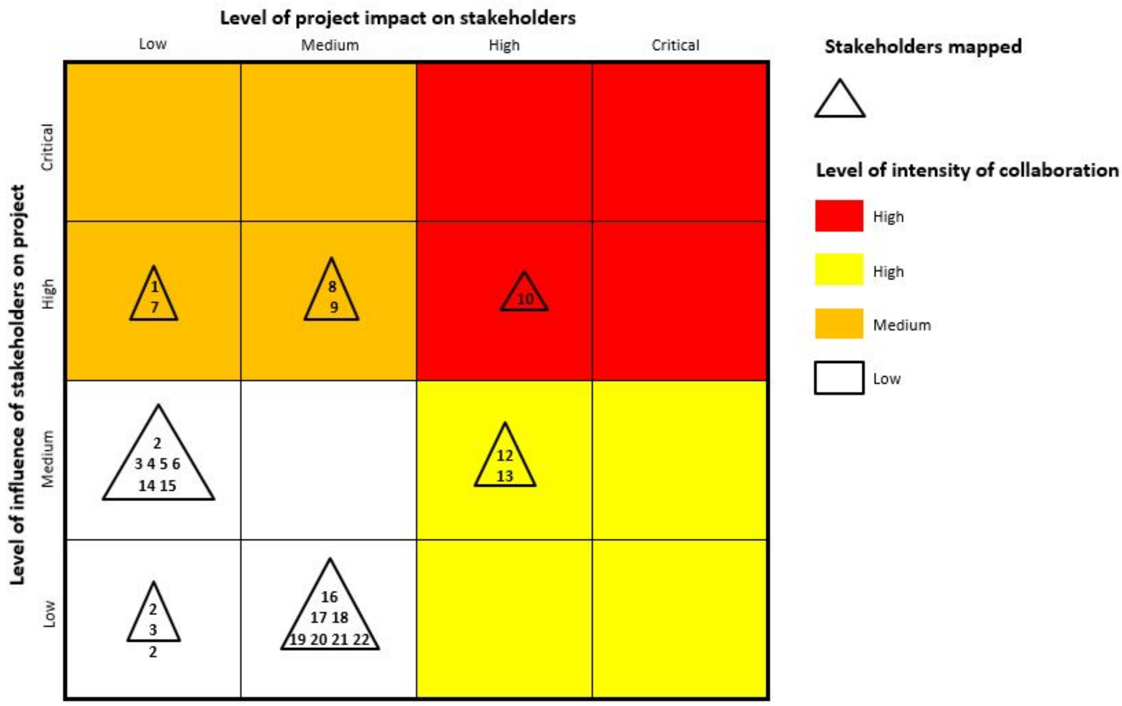

Figure 4-1 Stakeholder mapping

4.3.3 Disclosure phase

In line with international best practice, the stakeholders included in scoping stakeholder engagement will be consulted again for disclosure.

4.4 Stakeholder engagement activities

4.4.1 Scoping phase

4.4.1.1 Arranging the meetings

Community stakeholder engagement meetings were held between 5 and 12 October 2019. A total of 184 stakeholders were met across ten meetings. Figure 4-2 shows the locations in which community level meetings were held.

The SEP compiled for the ESIA contained provisions for a number of meetings at the non-community level to engage with stakeholders from regional, district and sub-district government, civil society and educational institutions/academia (see Table 4-1).

Pearl Petroleum holds regular meetings with the MNR regarding the KM250A Project and general matters. Feedback and input are obtained from the MNR, particularly on key issues such as social impacts, water and waste. The MNR has advised waiting until disclosure before holding further non-community engagement meetings, at which point a selection of other government ministries and other non-community stakeholders will be contacted to discuss the Project.

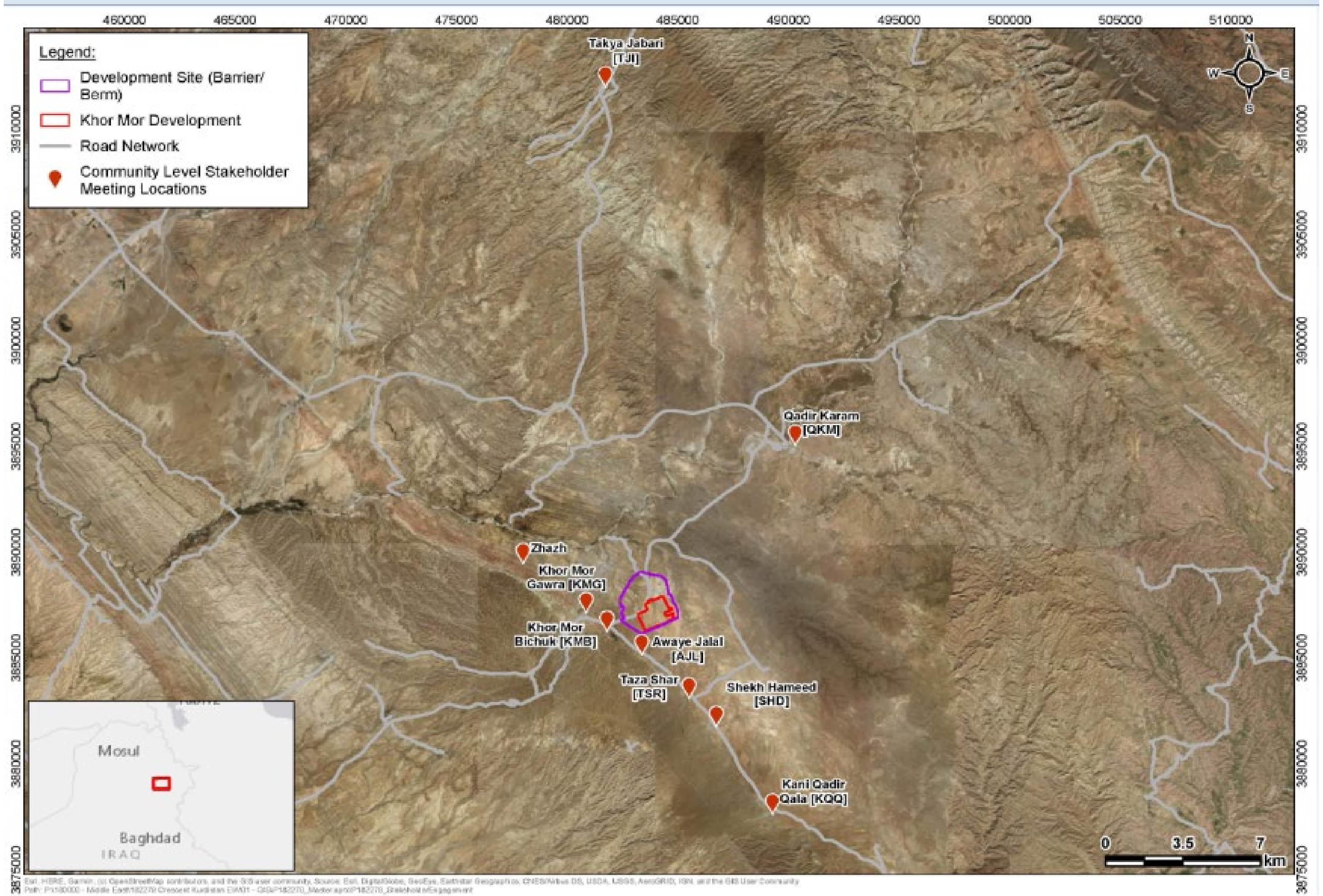

Figure 4-2 Locations of community level stakeholder engagement meetings

The main engagement methods for scoping stakeholder engagement at the community level included:

- correspondence exchange (phone calls) with village Anjuman to schedule the meetings
- individual, small group and community meetings to disseminate information and discuss the ESIA and Project-related issues and concerns.

Pearl Petroleum's Social Performance Department (SPD) arranged all meetings with stakeholders. Upon receiving the phone call from the SPD, the village Anjuman were asked to mobilise their communities on the date, time and in the location specified. The Anjuman were also requested to ensure that women were represented at all meetings.

The proposed date and time of the meetings was chosen to ensure maximum attendance from stakeholders and minimum interference to their daily routines. Venues were selected for ease of access to stakeholders, and seating capacity. In keeping with local protocol, all SDMs (Mayors) were met with prior to the community engagements.

4.4.1.2 Presentation materials used

Several materials (see Appendix 5) were prepared to enhance communication during the stakeholder meetings and ensure an informed discussion. These included:

- a PowerPoint presentation in English and Kurdish
- a Background Information Document (BID) in English and Kurdish
- posters in English and Kurdish.

4.4.1.3 Conducting the meetings

Community stakeholder engagement meetings were conducted by two ESIA consultants; one of the consultants facilitated the meetings whilst the other consultant recorded meeting attendance, meeting minutes and took photographs (where permission was granted). A representative from Pearl Petroleum's SPD was present at the meetings to introduce the ESIA consultants to the communities and answer any technical questions relating to the Project.

Meetings began with introductions and opening remarks by Pearl Petroleum's SPD about the purpose and format of the meeting to set the group at ease. The ESIA consultant responsible for facilitating the meetings highlighted that stakeholder participation was voluntary, and that stakeholders could decline to participate at any point during the meeting. The facilitator then asked participants for their permission to take photographs of the meeting and explained that no photographs will be taken unless consent is given.

Following this, the ESIA consultant introduced stakeholders to the Project, the ESIA, stakeholder engagement and the Grievance Management Procedure (Section 4.6) using visual aids (BID and posters, Appendix 5).

A Kurdish version of the BID was distributed to all stakeholders who attended the meetings.

Following the presentation, the meeting was opened for discussion and stakeholders were invited to ask questions, raise concerns and issues and provide suggestions and comments. The ESIA consultants responded, using the visual aids and reference material outlined above.

All meetings were held in Kurdish. Sufficient time was allocated to the question and answer session to allow for all stakeholders present to have their voices heard. An attendance sheet was used to record the details of the persons present at each meeting. During the meetings, details of the Project's community Grievance Management Procedure were also disclosed.

As noted in Section 4.4.1.1, the village Anjuman were asked to ensure that women were represented at all community meetings. Efforts were made to ensure that women had an equal opportunity to participate in the meetings and to learn about the Project and ESIA. Women were encouraged to share their issues and concerns during the meetings. As part of social baseline data collection, women's focus groups were also held (facilitated by a female ESIA consultant), providing further opportunities to learn and ask questions about the Project and the ESIA.

4.4.1.4 Recording the engagement activities

All stakeholder suggestions, comments and responses from the stakeholder team were recorded on the agreed meeting minutes template and group photographs were taken after seeking permission from the participants. Figure 4-3, Figure 4-4 and Figure 4-5 present a sample of the photographs taken at the community stakeholder meetings in Khor Mor Bichuk, Shekh Hameed and Awaye Jalal.

Figure 4-3 Community meeting at Khor Mor Bichuk, 5 October 2019

Figure 4-4 Community meeting at Shekh Hameed, 5 October 2019

Figure 4-5 Community meeting at Awaye Jalal, 8 October 2019

As noted in Section 4.4.1.3, women's focus groups were undertaken to provide further opportunities to learn and ask questions about the Project and the ESIA. An example of a women's focus group is shown in Figure 4-6.

Figure 4-6 Women's focus group discussion at Khor Mor Gawra, 5 October 2019

4.4.2 Disclosure phase

Further stakeholder engagement meetings will be held during the public disclosure phase of the ESIA with the aim of ensuring that stakeholders are informed about and comprehend the outcome of the ESIA – in particular the identified impacts and mitigation measures – and that they can provide comments and questions related to the draft ESIA report to be addressed in the final ESIA report.

In line with international best practice, the stakeholders included in scoping stakeholder engagement will be consulted again for disclosure.

4.4.2.1 Arranging the meetings

The steps for arranging the stakeholder engagement meetings during scoping (Section 4.4.1.1) will be similar during disclosure.

4.4.2.2 Presentation materials used

A non-technical summary (NTS) in English and Kurdish, outlining the results of the ESIA and mitigation measures, will be used during disclosure.

4.4.2.3 Conducting the meetings

Two ESIA consultants will conduct the meetings; one of the consultants will facilitate the meetings whilst the other consultant will record meeting attendance, meeting minutes and take photographs (where permission is granted). A representative from Pearl Petroleum's SPD will be present at the meetings to introduce the ESIA consultants to the communities and answer any technical questions relating to the Project.

As during scoping, meetings will begin with introductions and opening remarks. The facilitator will highlight that participation is voluntary and will request permission to take photographs of the meeting. The outcomes of the ESIA study will then be presented to the stakeholders by an ESIA consultant using the NTS and stakeholders will be given the opportunity to raise questions and comment on the study findings.

Meetings will be held in Kurdish and a Kurdish version of the NTS will be distributed to all attending stakeholders.

4.4.2.4 Recording the engagement activities

The steps for recording the stakeholder engagement meetings during scoping will also apply during disclosure (Section 4.4.1.4).

4.5 Analysis of stakeholder issues and concerns raised

This section presents the analysis of issues raised by stakeholders.

Stakeholder issues and concerns were categorised by topic and sub-topic:

- stakeholder engagement (Project and ESIA-related)
- social (employment, community development and infrastructure, land and property, land-based livelihoods, workers' safety, security and welfare)
- environmental (general impacts)

- Project characteristics (security)
- other comments made.

Figure 4-7 shows the frequency by which certain stakeholder issues were raised during community meetings. The largest number of issues raised were in the social category and these were analysed further (Figure 4-8). Other comments raised related to workers' health and safety, with some suggesting that they had been dismissed or compensated unfairly by Pearl Petroleum following injury or retirement in the past. It was explained that some jobs at Pearl Petroleum are only temporary and other questions would require follow-up. Similar to community meetings, the most prevalent type of issue raised during women's focus groups were in the social category.

A small proportion of stakeholders during the community meeting in Takeya Jabari were concerned around the environmental impacts of the Project, and the damage that Project vehicles could have on the road infrastructure.

Issues and concerns raised regarding the social topic were analysed further (Figure 4-8). In nine of the ten community level meetings held, opportunities for employment during the Project were the predominant issue. Concerns were also raised in Zhazh, Awaye Jalal and Khor Mor Gawra about the number of graduates who are unemployed, and whether there will be available job opportunities for them. Women from the PACs of Kani Qadir Qala, Khor Mor Bichuk and Khor Mor Gawra emphasised the need for training and skills development opportunities for women and expressed an interest in employment opportunities related to the Project.

During community meetings, stakeholders also raised questions about community development and infrastructure, with several (Qadir Karim, Shekh Hameed, Zhazh, Awaye Jalal, Takeya Jabari, Taza Shar and Kani Qadir Qala) emphasising the need for facilities such as medical centres, schools, electricity and water systems in their villages. Such needs were similarly conveyed during women's focus groups with particular reference to improved roads, school services (e.g. transportation), electricity supply and water provision Furthermore, stakeholders were concerned over the quality of the road systems in the PACs. Some stakeholders in Qadir Karim enquired about training courses for youths looking for employment opportunities in towns and villages surrounding the AOI.

Questions were raised in relation to compensation for land owners. Some stakeholders in Khor Mor Bichuk, Khor Mor Gawra and Shekh Hameed were dissatisfied with the rate of compensation that they received for their land during previous land acquisition at the existing facility (a single payment). It was explained that it was in the contract that was signed, and that stakeholders could contact Pearl Petroleum's SPD to discuss the issue further and raise a formal grievance should they wish to, following the Community Grievance Management Procedure (see Section 4.6). Stakeholders in Shekh Hameed also raised concerns over the 'one-off' payment method that they will receive, and the low prices estimated for their land.

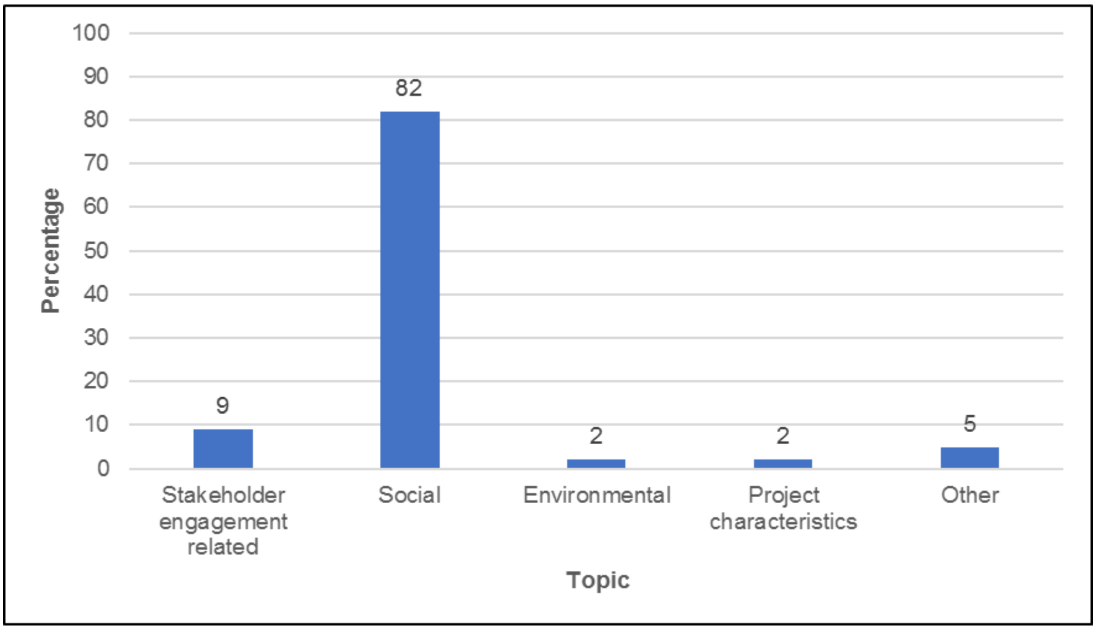

Figure 4-7 Frequency of issues raised by topic across community meetings

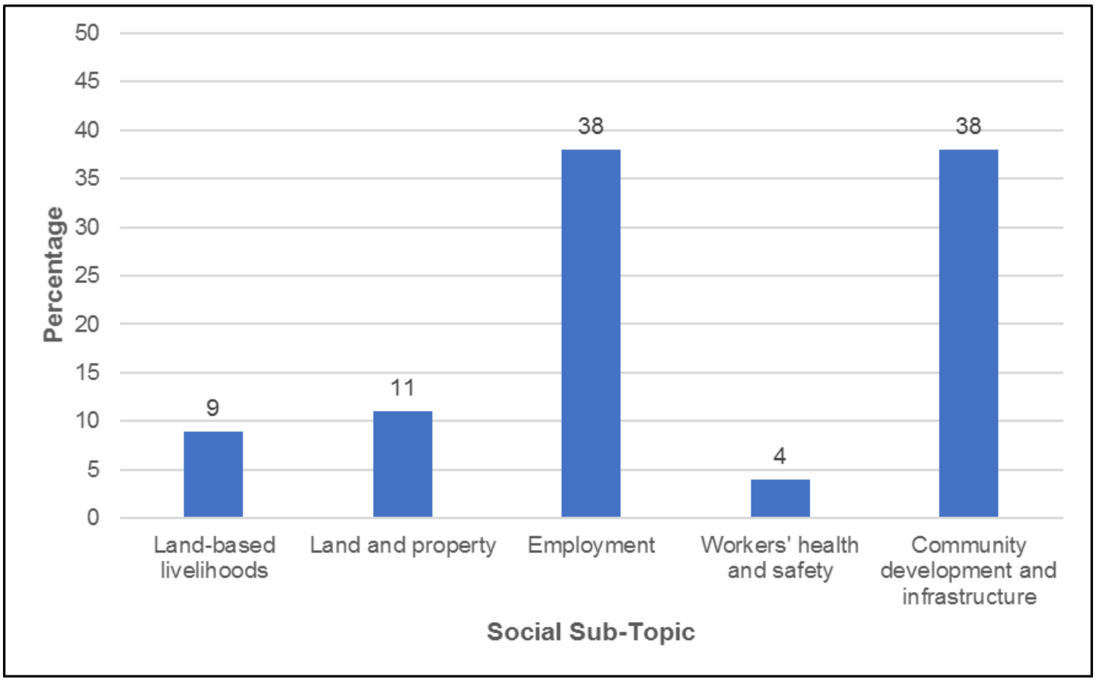

Figure 4-8 Frequency of issues raised by social sub-topic across community meetings

As stated in Section 4.4.1.1, scoping phase engagement meetings with non-community stakeholders (aside from the MNR) have not been possible within the context of this ESIA. During the meetings with the MNR on the 13 November 2019 and 11 December 2019, senior representatives from the MNR raised concerns about the potential for the Project to lead to significant social impacts. Environmental issues related to water, waste and air quality were acknowledged but considered to be of less significance relative to social impacts. Emphasis was placed on the importance of maximising local employment and business opportunities, based on open and transparent criteria, and ensuring that any social investment initiatives related to the Project and/or the existing facility benefits local communities as a whole.

4.6 Community Grievance Management Procedure

In line with Pearl Petroleum's Social Performance Standard (2019), the Community Grievance Management Procedure for the Project follows the existing Community Grievance Management Procedure. Developed in May 2019, the procedure is fully operational and open to all stakeholders, including those at the non-community level.

Figure 4-9 shows a summary of the community Grievance Management Procedure. The procedure is comprised of six steps; receipt, assessment and recording, investigation, resolution, implementation, and close out. Where a grievance is confirmed to be valid, follow-up actions are undertaken to resolve the grievance. Typically, this involves face-to-face meetings between representatives from Pearl Petroleum and the complainant, the outcomes/results of which are recorded in documents which are then signed by both parties. This process will apply to any of the grievances expressed during stakeholder engagement for the KM250A Project (see Section 4.5) where a formal complaint is received.

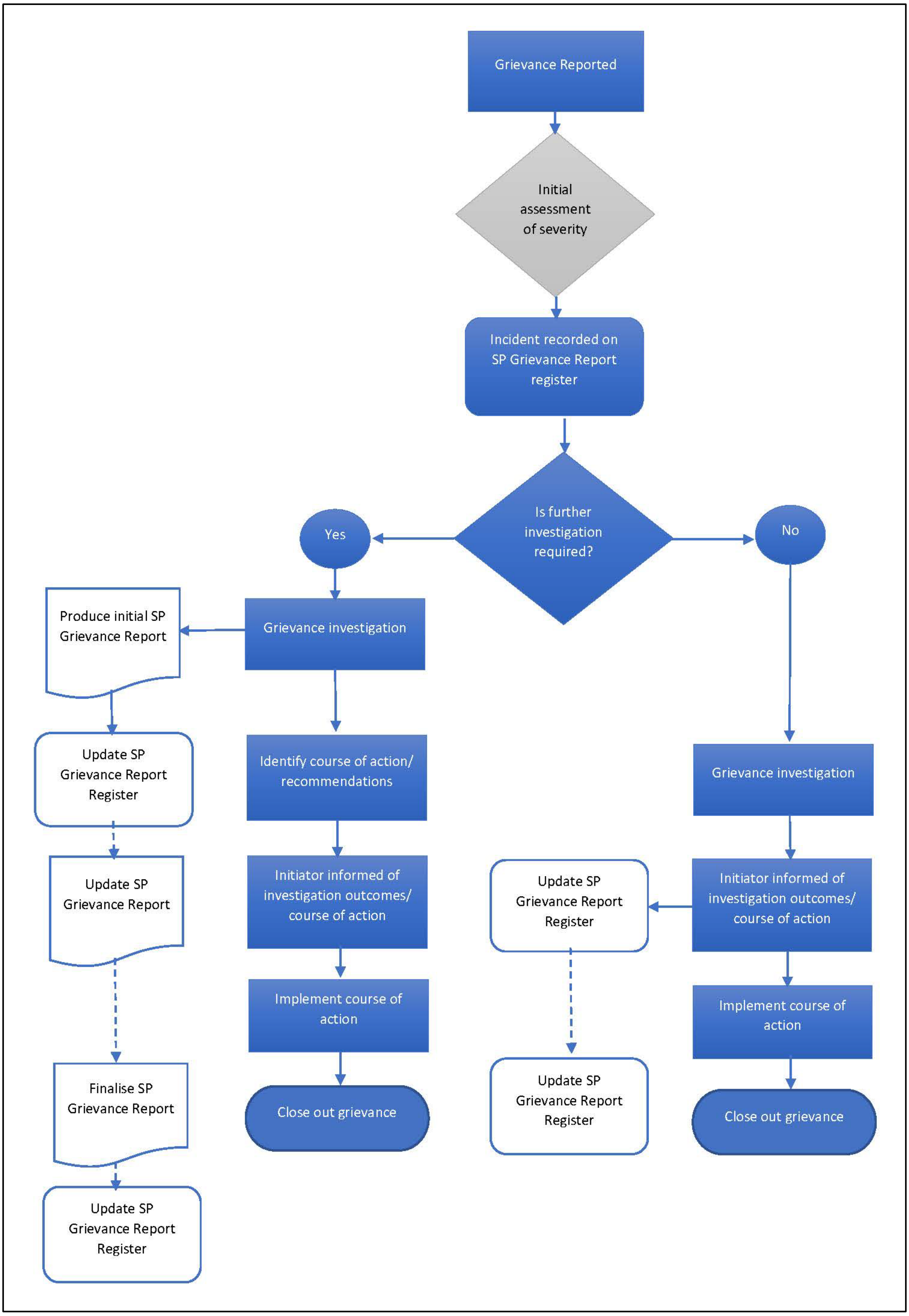

Figure 4-9 Project community Grievance Management Procedure

4.7 Ongoing engagement

Stakeholder engagement will continue during the public disclosure phase of the ESIA and following the submission of the final ESIA report in order to provide stakeholders with Project updates, as appropriate, across the Project lifetime. These activities will be described in the SEP that is implemented by Pearl Petroleum at the existing facility. Engagement with the PACs will follow the established mechanisms through Pearl Petroleum's SPD and its team of Social Liaison Officers. The community Grievance Management Procedure will remain fully operational and will provide stakeholders with ongoing means to lodge Project-related grievances and concerns.

5 POTENTIAL IMPACTS OF THE PROJECT

5.1 Introduction

This section concerns identification, quantification (where possible and appropriate), and assessment of the environmental impacts associated with construction, pre-commissioning, commissioning, operation and decommissioning phases of the Project. A methodology has been selected that takes into account the impacts on the physical environment (air quality, soil, surface and ground water quality), the biological environment and the socio-economic environment (human activities).

This section provides details of the assessment methodology used to assess impacts on the physical environment (air quality, soil and groundwater quality), impacts on the ecology (flora, fauna), and disturbance of human activities. This section records the findings of the assessment as follows:

- Sections 5.2 to 5.5) lays out the scope of this impact assessment and provides a detailed methodology for assessing the significance of expected impacts.
- Section 5.7) outlines the findings for each impact for planned activities (without and with application of mitigation measures) and are presented in tabular form at the end of each impact sub-section.
- Section 5.8 presents the cumulative impacts in general.
- Section 5.9 presents an impact assessment associated with ecosystem services.
- Section 5.10 sets out the findings of an assessment of unplanned scenarios.

Planned activities are either those that correspond to routine or non-routine operations of the KM250A Project. Routine operations concern normal functioning of all plant processes. Non-routine operations concern response to upsets at the plant requiring flaring or blowdown to avoid overpressure, or minor spills or leaks that only affect the immediate process area. Non-routine events will be minimised through implementation of controls developed and implemented by the KM250A process safety team (Hatch, 2019j).

Unplanned activities are those that create conditions that are usually considered emergencies, with risk of injury or loss of life to workers and damage to infrastructure.

Flare thermal radiation and dispersion studies were undertaken (Hatch, 2019i) to determine the potential flaring requirements, associated flare system sizing and assess the potential safety impacts of flaring and flame out events. Flare stack heights and exclusion zones were determined to ensure on-site personnel are not subject to unacceptable thermal radiation levels and that there is no significant offsite safety impact from flaring. The dispersion of polluting air emissions outside of the KM site fenceline will create potential offsite environmental impacts from flaring, especially concerning noise, visual impact, and air quality due to combustion products. The environmental and social impacts of flaring events are discussed in the planned activities impact assessment.

Section 6 subsequently sets out the impacts controls and mitigation measures related to planned activities, Residual impacts are then presented in relation to initial impacts identified as ‘significant’, based on any expected reductions in impact significance that would be likely to result from application of the mitigation measures. The most significant negative impacts are then discussed in detail. As per best international practice, mitigation measures are required for significant negative impacts only, although measures to enhance benefits have been proposed as well, where appropriate. The main goal of this process is to reduce impact significance to levels that are ‘as low as reasonably practicable’ (ALARP).

5.2 Scope of the environmental and social impact assessment

The scope of this ESIA is limited to issues which Pearl Petroleum can control or influence. The approach to evaluation of environmental and social impacts associated with the planned Project concerns assessment of the sensitivity of potential receptors and the magnitude of potential impacts on those receptors associated with Project activities in relation to each of the Project development phases. Sensitivity and magnitude rankings associated with each impact are used to assess the significance of the respective impacts.

The general approach for the framework is to:

- Summarise existing environmental and social conditions of the Project footprint and surrounds, including the sensitivity of receptors, which may be affected by changes in the existing conditions (where ‘receptors’ also includes ‘sites’, ‘environmental, social and health values’ and/or ‘resources’, where relevant).
- Consider potential, credible environmental, social and health issues associated with the Project during all phases, and consequent credible impacts within the context of the existing conditions. Identification and evaluation of the potential impacts is based on knowledge of the existing environment, the Project description, experience with similar operations in similar biophysical and social environments, and issues of concern to stakeholders.
- Identify appropriate management and mitigation measures. The measures identified must be technically and economically feasible within the context of the Project and reflect Pearl Petroleum’s commitment to protect the environment and contribute to the sustainable social and economic development of communities.
- Assessment of potential residual impacts over the life of the Project assuming the successful implementation of the identified management and mitigation measures.

The assessment is based on:

- fulfilment of KRI legal and regulatory requirements
- compliance with the relevant environmental quality standards specified in the national (Iraqi) regulations that are relevant to the proposed site activities
- compliance with Pearl Petroleum policies, standards and procedures
- compliance with the international conventions and regional agreements signed and ratified by Iraq
- compliance with International Finance Corporation (IFC) environmental, health and social (EHS) guidelines (IFC, 2007) Performance Standards (IFC, 2012), IFC cumulative impact assessment and management guidance for the private sector in emerging markets (IFC, 2013)
- compliance with commitments to the International Environmental Guidelines and Industry best practices as an expression of Best Available Techniques (BAT) for gas plant construction and associated operations performed in settings similar to Khor Mor.

Where objective, quantitative criteria, guidelines or standards are not available or are subject to interpretation, impact significance is determined according to the qualitative criteria.

5.3 Identification of Project aspects and potential impacts

Within the context of this ESIA, an aspect is 'an element of an organisation's activities, products or services that can interact with the environment' (International Standards Organisation 14001). In the ESIA, an 'aspect' of the proposed activities that can cause changes to environmental and social baseline conditions has a possible 'impact'.

5.3.1 Environmental impacts

An environmental aspect is 'an element of an organisation's activities, products or services that can interact with the environment' (International Standards Organisation 14001). In the ESIA, an 'aspect' of the proposed activities that can cause changes to the environmental and social baseline conditions has a possible 'impact'. Aspects of the Project that can cause changes to the baseline environmental and social conditions have been identified and grouped according to:

- physical presence
- physical disturbance of the environment and of ecology (e.g. changes to the land or its uses, harm to plants and animals)
- change to the quality of the air (by the emission of pollutants)
- change to the quality of the soil (e.g. due to the storage of chemicals)
- changes to the quality of the groundwater or surface water (e.g. by the discharge of various types of liquids)
- use of utilities/resources (water, fuel, etc)
- nuisance due to the generation of noise, vibration, odour or change to the visual amenity of the area
- disturbance of people and communities, including socio-economic impacts (e.g. by noise from equipment, fugitive emissions, interference with road traffic, and land take impact on grazing animals).

Environmental impacts that were identified and considered relevant to the KM250A Project are summarised in Table 5-1

5.3.2 Social impacts

Ten socio-economic topics were identified as relevant during the social baseline surveys and ESIA-related stakeholder engagement. These topics are:

- local and regional economy
- employment and skills development
- labour and working conditions
- land access and livelihoods
- community safety and security
- public health
- infrastructure and services
- cultural heritage
- traffic

- visual impacts
- vulnerable groups.

Each of these have been assessed against the Project aspects, in order to identify potential impacts. The following sections provide further detail of the receptor context and relevance, description of impact magnitude arising from the Project aspects and the proposed mitigation measures. Summary tables are provided for each impact in the following sections. Residual impacts are then assessed.

Social impacts that were identified and considered relevant to the KM250A Project are summarised in Table 5-2.

Table 5-1 Environmental impact identification matrix

I		Air quality	Soil quality	Groundwater quality	Noise quality	Ecological and biological environment
KM250A Project activities (aspects)	**Construction phase**					
	Early works (civil work, site preparation, earth works for foundation and internal roadways)	X	X		X	X
	Installation of main equipment	X	X		X	X
	Use of construction equipment	X	X		X	X
	Site gravelling and levelling	X	X		X	X
	Self-contained construction camps including accommodation; catering/welfare facilities; workshops, warehouses and storage yards	X	X			X
	Gas plant construction	X			X	X
	Flowlines construction including: RoW preparation, stripping and grading; Pipe stringing; Welding; Excavating trenches; Lowering; Backfilling (reinstating)	X	X		X	X
	Requirements for chemicals and other raw materials		X	X		
	Transportation of process equipment, pipe racks, piping and other materials by roads	X			X	X
	Construction workforce commuting to/from site	X				X
	Site security					X
	Pre-commissioning and commissioning phase					
	Testing Gas plant units					
	Flowline hydrotesting and commissioning (water intake, discharge and safety issues)		X	X		X
	Requirements for chemicals and other raw materials			X		
	Operations phase					
	Requirements for chemicals and other raw materials		X	X		
	Export of gas, LPG and condensate via pipelines or bulk transport	X		X		
	Emergency response and relief, flare and blowdown systems	X				
	Maintenance activities	X			X	X
	Permanent operations workforce and accommodation (80-100 ppl/rotational)					X
	Decommissioning					
	Shutting-down and de-pressurizing gas plant and eventual decommissioning of a gas processing facility located within the existing site boundary, including: - remove all hydrocarbons to render the plant inert - remove all chemicals and certify that the whole plant is hydrocarbon and hazardous chemical-free - disconnect and dismantle the equipment, and remove modules and scrap from the site for refurbishment or recycling - demolish structures and paving and remove the materials from site as inert waste - level the site and undertake soil and groundwater survey to determine whether any remediation is needed. - spread stored topsoil for site rehabilitation	X	X	X	X	X

Table 5-2 Socio-economic impact identification matrix

I		Local economy	Regional economy	Employment and skills development	Labour and working conditions	Land access and livelihoods	Community safety and security	Public health	Infrastructure and services	Cultural heritage	Vulnerable groups
KM250A Project activities (aspects)	**Construction phase**										
	Early works (civil work, site preparation, earth works for foundation and internal roadways)	X		X	X		X	X	X		
	Installation of main equipment	X		X	X		X	X	X		
	Use of construction equipment	X		X	X		X	X			
	Site gravelling and levelling	X		X	X		X		X		
	Self-contained construction camps including accommodation; catering/welfare facilities; workshops, warehouses and storage yards	X		X	X		X	X	X		X
	Gas plant construction	X		X	X		X	X	X		X
	Flowlines construction including: RoW preparation, stripping and grading; Pipe stringing; Welding; Excavating trenches; Lowering; Backfilling (reinstating)	X		X	X	X	X	X	X	X	X
	Requirements for chemicals and other raw materials	X			X		X				
	Transportation of process equipment, pipe racks, piping and other materials by roads			X	X		X		X		
	Construction workforce commuting to/from site			X	X		X	X	X		
	Site security			X	X	X	X		X		X
	Pre-commissioning and commissioning phase										
	Testing Gas plant units			X			X	X	X		
	Flowline hydrotesting and commissioning (water intake, discharge and safety issues)			X	X		X	X	X		X
	Requirements for chemicals and other raw materials										
	Operations phase										
	Requirements for chemicals and other raw materials		X								
	Export of gas, LPG and condensate via pipelines or bulk transport	X	X				X	X	X		
	Emergency response and relief, flare and blowdown systems										
	Maintenance activities			X			X	X	X		
	Permanent operations workforce and accommodation (80-100 ppl/rotational)		X	X	X		X	X	X		
	Decommissioning										
	Shutting-down and de-pressurizing gas plant and eventual decommissioning of a gas processing facility located within the existing site boundary, including: - remove all hydrocarbons to render the plant inert - remove all chemicals and certify that the whole plant is hydrocarbon and hazardous chemical-free - disconnect and dismantle the equipment, and remove modules and scrap from the site for refurbishment or recycling - demolish structures and paving and remove the materials from site as inert waste - level the site and undertake soil and groundwater survey to determine whether any remediation is needed. - spread stored topsoil for site rehabilitation			X	X	X	X	X	X		

5.4 Impact assessment approach

The assessment of the proposed Project's environmental and social impacts was undertaken within the context of the respective area of influence (AOI):

- Soil (see Section 3.2.3)
- Water resources (see Section 3.2.4)
- Noise (see Section 3.2.5)
- Air (see Section 3.2.6)
- Biodiversity (see Section 3.3)
- Social, socio-economic and cultural heritage (see Section 3.4).

Visual impacts, which are at least partly a matter of perception, are discussed within the social/socio-economic section.

A schematic of the impact assessment process for planned activities is provided in Figure 5-1.

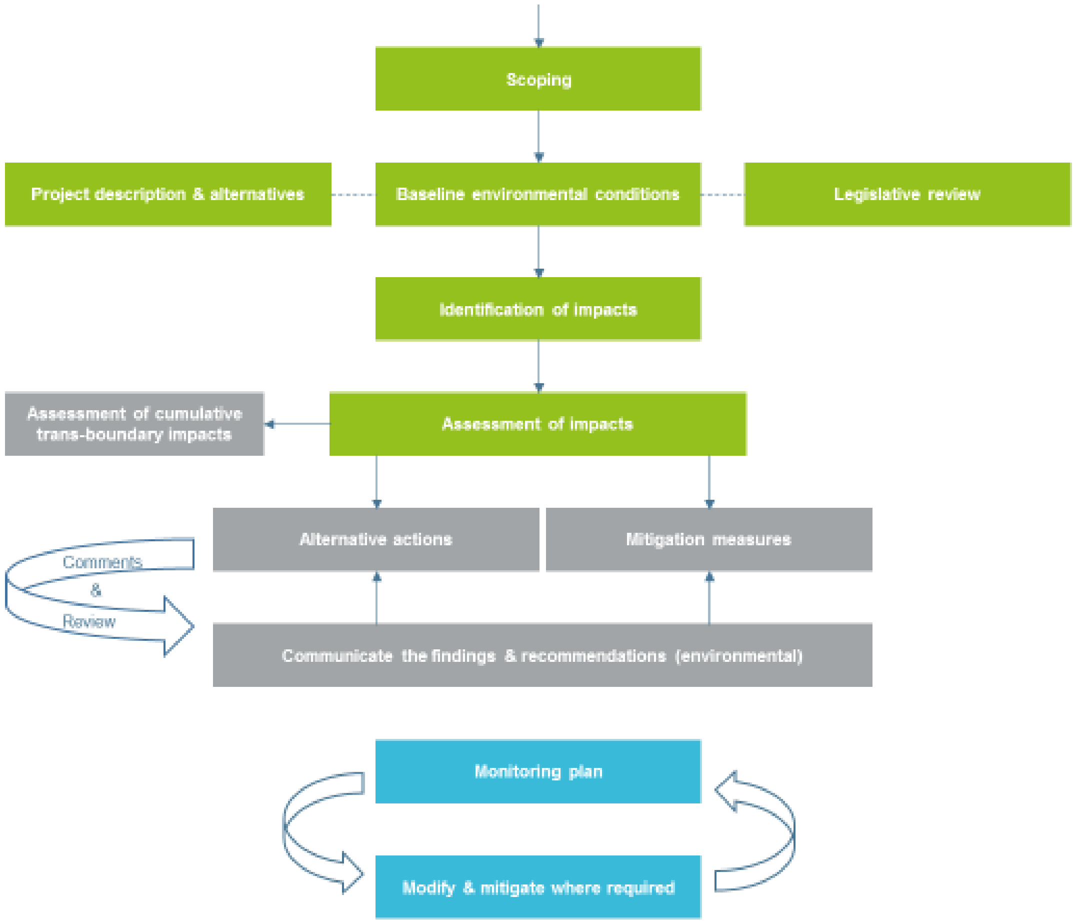

Figure 5-1 Schematic of the impact assessment process

Various types of impacts were considered in this analysis, as follows:

- negative or positive (benefits)
- direct: an impact that results from a direct interaction between some feature of a planned action and the receiving environment (e.g., land take)
- indirect: an impact that results from other developments or activities that may occur as a consequence of the original development
- reversible or irreversible
- secondary: an impact that follows on from the primary interactions between a Project and its environment as a result of subsequent interactions within the environment (e.g., impact on land users through loss of land)
- cumulative.

Perceived impacts, based on the views of stakeholders, may not be scientifically derived, but must nonetheless be considered.

The identified impacts are assessed according to the following criteria and associated scores:

- the **magnitude** of impact
- the **sensitivity** of impact.

The significance of an impact (rated major, high, moderate, minor, slight or positive) is a function of the magnitude of the impact and sensitivity of the potentially affected receptor(s).

The assessment criteria for determining magnitude of the impact and sensitivity of the respective receptor(s) is described in the following sub-sections. These are followed by a description of the methodology for determining the significance of the impact.

5.5 Impact assessment methodology

5.5.1 Planned activities

Sections 5.5.1.1 through 5.5.1.3 describe the methodology for assessing impacts for planned Project activities (for all Project phases) for all impacts except those related to greenhouse gas (GHG) emissions. Section 5.5.1.4 describes the methodology applied for GHG emissions.

5.5.1.1 Impact magnitude

The magnitude of an impact is determined following consideration of a number of factors, as follows:

Severity considers the scale or degree of change from the existing situation as a result of the impact.

Geographic extent considers if the effect is national (or international), regional, local or limited.

Duration considers the timescale of the effect, i.e., if it is temporary, short term or long term. This takes into account reversibility of the effect, where an irreversible impact is one where recovery on a reasonable timescale is not possible. Duration is determined with respect to specific environmental and social impacts.

Frequency considers the regularity of the effect, i.e., continuous, frequent, infrequent or rare.

Regulations, standards and guidelines: the status of the impact in relation to regulations (e.g., discharge limits), standards (e.g., environmental quality criteria) and guidelines. Regulations, standards and guidelines include both Iraq and international best practice standards.

Table A6.1 in Appendix 6 presents the criteria used to evaluate the magnitude of potential impacts (slight, low, medium and high impact) on specific aspects of the physical, biological and socio-economic environments based on the above criteria.

5.5.1.2 Receptor sensitivity

Receptor sensitivity (or sensitivity of the receiving environment) is defined as the susceptibility of the receptor to change, including its capacity to adapt to, or accommodate (resilience), the kinds of changes that the Project may bring about. Each identified receptor may have a different sensitivity to the potential impacts.

The sensitivity of the receptor is classified as low, medium or high. Sensitivity is based on a variety of criteria, for example the carrying capacity of an area in terms of wildlife, or air pollution and its impact on human health. Table 5-3 provides a commonly-used set of criteria for broad determination of the sensitivity of a receptor. The specific criteria used to evaluate the sensitivity of the possible receiving environment/receptors for this Project for each impact category are shown in Table A6.2 in Appendix 6.

Table 5-3 Criteria for determining receptor sensitivity

Intensity	Description
Low	The receiving environment or receptors where disturbance due to the Project impacts is minimal or tolerant to changes from the Project. (e.g. desert, industrial areas)
Medium	The receiving environment or receptors are moderately sensitive or reasonably tolerant of changes, where it may cause some disturbance
High	The receiving environment or receptors where people or habitats are particularly susceptible to changes from the Project (e.g. residential areas, schools, ecological sensitive areas)

5.5.1.3 Impact significance

The assessment of impacts would be undertaken by examining both the magnitude of the impact and the sensitivity of the receptor that is affected. Together, the magnitude of the impact and the sensitivity of the receptor(s) allow forecast of the significance of the impact. This interaction between magnitude and sensitivity can be expressed in matrix form, thereby bringing a transparent structure to complex interactions (Table 5-4). The first (top) row represents the receptor sensitivity ratings ranging from high to low, as defined in Appendix 6 (Table A6.2). The first (left-hand) column represents the expected magnitude of the impact, based on negative magnitude ratings of the impact ranging from high to slight as defined in Appendix 6 (Table A6.1). The last row in that column represents positive (beneficial) impacts, for example increase in employment due to the Project.

The significance of the overall assessment for each environmental aspect were defined as follows, based on best international practice:

- **major significance**: impacts that have the potential to cause irreversible or widespread harm to an environmental or social value that is unique or has a limited capacity to adapt to change. Avoidance through appropriate design responses is the only effective mitigation.
- **high impact:** impacts that have the potential to exacerbate threatening processes affecting the intrinsic characteristics and structural elements of an environmental or social value or its ability to function. While replacement or recovery is possible, avoidance through appropriate design responses is preferred.
- **moderate impact**: impacts that have the potential to degrade or upset an environmental or social value due their scale or its susceptibility to change. The value's abundance or resilience to change ensures that replacement and recovery is achievable.
- **minor impact**: when an environmental or social value with a low sensitivity is exposed to minor alterations that will not affect its viability, provided standard controls are adopted.
- **slight impact**: when an environmental or social value with a low sensitivity is exposed to minor alterations which will not result in any noticeable change.
- **positive impact**: impacts that have the potential to create beneficial or uplifting effects on an environmental or social value.

Major, high and moderate impacts are considered 'significant' and thus warrant identification of possible mitigation measures.

Impacts of minor or slight impact are considered not to warrant additional mitigation measures, although in some cases low-cost actions are proposed that would be expected to further reduce corresponding impact significance.

Table 5-4 Matrix of significance for planned activities

Magnitude of impact	Sensitivity of receptor		
	High	**Medium**	**Low**
High	Major	High	Moderate
Medium	High	Moderate	Minor
Low	Moderate	Minor	Slight
Slight	Minor	Slight	Slight
Positive	Positive	Positive	Positive

Positive impacts, particularly within the socio-economic sphere (for example increase in local employment due to the Project), can result from Project activities. In this circumstance, such impacts have not been ranked but were assigned a 'positive impact' for simplicity (see Table 5-4) and discussed as appropriate, based on the assumption that any measures that would optimise benefits will be effectively implemented.

The assessment of **residual** impacts is based on the effective implementation of:

(i) avoidance, mitigation and management measures for adverse impacts
(ii) measures to optimise benefits

5.5.1.4 Assessment of the impacts of greenhouse gas emissions

The Institute of Environmental Management and Assessment (IEMA, 2017) guidelines state the following with regard to assessment of the impacts of GHGs:

- all projects create GHG emissions that contribute to climate change
- climate change has the potential to lead to significant environmental effects
- there is a GHG emission budget that defines a level of dangerous climate change whereby any GHG emission within that budget can be considered as significant.

Therefore, in the absence of any significance criteria or a defined threshold, all GHG emissions can be considered significant and mitigating measures should be identified. This is the general approach taken. The estimated Project GHG emissions will be estimated and compared to the Iraqi total to determine whether it constitutes a large portion of national GHG emissions.

5.5.2 Risk assessment methodology for unplanned activities

An unplanned event is defined as 'a reasonably foreseeable event that is not planned to occur as part of a project, but which may conceivably occur as a result of project activities (e.g. accidents), even with a low probability'. Unplanned events may occur during any phase of a project. The risk assessment is based on application of experience of events or incidents to predict risk in the future. Consequences of potential impacts are first determined using severity levels and definitions.

The KRG requires that the impact of unplanned events on public health and safety and the likelihood of their occurrence[20] be taken into consideration, including:

- traffic likely to be generated, including the impact of increased traffic on the local communities as well as the level of risk and methods of prevention of oil spills on roads and highways
- fugitive emissions and unplanned gas releases (by flaring)
- fires, spills, or other accidents.

A desk study was carried out by the front end engineering and design contractor for the Project (Hatch) for unplanned events which is summarised in the document 'CPF Fire & Dispersion Hazard Analysis' (Hatch, 2018), including a desktop risk assessment and ranking.

The objective of the hazard analysis for unplanned activities was to identify representative accidental release failure cases for the proposed KM500 facilities and carry out sufficient consequence modelling to provide input into the central processing facility equipment layout and spacing. Consideration of releases from the existing Khor Mor facilities is excluded from this assessment.

[20] See 'Technical Guidelines on Environmental Impact Assessments for Petroleum Operations in the Kurdistan Region of Iraq' (March 2015).

The hazardous consequences identified in the risk analysis study were as follows:

- flammable gas cloud
- jet flame
- flash fire
- explosion
- pool fire
- toxic gas cloud.

Minor leaks, spills, fugitive emissions and venting are not considered within the framework of this unplanned activity risk assessment as they occur routinely and can be easily controlled by routine procedures. The impact of increased traffic on local communities as well as the level of risk and methods of prevention of oil spills on roads and highways are similarly not covered by the Hatch assessment. The potential impacts of these events will be addressed in the ESIA report section on planned activities, although they are considered non-routine.

5.6 Identification of mitigation measures and assessment of residual impacts

Where necessary, mitigation measures have been proposed to further reduce the potential impact to ALARP (as low as reasonably practicable) or to maximise any potential benefits. This has generally been done in the case of 'significant' impacts. The approach taken to identify and incorporate mitigation measures into the project has been based on the best practice hierarchy of decisions and measures, in order of priority, as follows:

- avoid at source/reduce at source
- abate on-site
- abate offsite/at receptor
- repair or remedy.

The above hierarchy is aimed at ensuring that, wherever possible, potential negative impacts are mitigated at the source rather than mitigated through restoration after the impact has occurred.

The mitigation measures will be tracked through to the Project commitments register as clear unambiguous commitments. The commitments register is the authoritative source of all mitigation measures that the project proposes to implement.

Mitigation measures and other actions judged necessary for reducing impacts below 'significant' are 'SMART', that is, they have been developed according to the following criteria:

- *Specific* – target a specific area for improvement
- *Measurable* – quantify or at least suggest an indicator of progress
- *Assignable* – specify who will do it

- *Realistic* – state what results can realistically be achieved, given available resources
- *Time-related* – specify when the result(s) can be achieved.

In some cases, additional measures may be proposed even though significance is rated at minor or less. As mentioned earlier, additional measures for positive impacts may be proposed in order to maximise the benefits.

5.7 Impact assessment for planned activities

5.7.1 Air quality

5.7.1.1 Construction phase

5.7.1.1.1 Baseline context and receptor sensitivity

Several small villages (Table 3-14) located within the KM250A Project air quality AOI are considered to be sensitive receptors in terms of atmospheric emissions released during the Project construction phase, in addition to emissions released from the existing gas plant. Residential areas along site access routes have also been designated sensitive receptors due to emissions from Project traffic. There are both agricultural and grazing areas within the AOI. There is also an accommodation camp within the Khor Mor site fenceline, and there will be a construction camp, similarly within the site fenceline. The sensitivity of receptors has been rated **medium**.

5.7.1.1.2 Project aspects

All construction activities that generate dust or combustion emissions, including KM250A Project traffic.

5.7.1.1.3 Magnitude of potential impacts

The level of atmospheric emissions released by construction activities (i.e. site clearance, preparation, excavation and grading) will affect air quality in the short term. Impact will largely be at the site and immediate vicinity for the duration of construction activities. The scale of impact will depend on the type of construction activity, prevailing meteorological conditions and the effectiveness of control measures. In general terms, there are two key sources of emissions:

- exhaust emissions from site plant, equipment and vehicles
- fugitive dust emissions from site activities.

Further details are provided in the following sections.

Exhaust emissions from plant and vehicles

The operation of vehicles and equipment powered by internal combustion engines can result in an increase in air emission of exhaust gases containing the pollutants nitrous oxides (NO_X), particulate matter particles smaller than 10 microns (PM_{10}), volatile organic compounds (VOCs), and carbon monoxide (CO). The quantities emitted depend on factors such as engine type, service history, pattern of usage and fuel composition (details on the moving and non-moving equipment that will be active during the construction phase of the Project are described in Section 2.6.1.3).

Vehicle and plant movements result in emissions to atmosphere of exhaust gases, but such emissions are unlikely to be significant as vehicle movements to and from the site will be on a temporary basis, and plant emissions are unlikely to be significant when compared to background nitrogen dioxide (NO_2) and PM_{10} concentrations.

Emissions from plant and vehicles operating at the gas plant or flowline construction sites have a very localised impact and are unlikely to have an impact on air quality at the nearest human receptors. There will be a temporary increase in the movement of heavy goods vehicles on the road network will increase for the duration of the works which could lead to a rise in pollutant concentrations. However due to the short-term nature of the works, coupled with the limited number of receptors that could be affected, the significance of the potential impact was assessed as **minor** adverse.

Fugitive dust emissions

Fugitive dust emissions generated by construction activities are likely to be variable in nature and will depend upon the type and extent of the activity, soil type and moisture, road surface conditions and meteorological conditions. Periods of dry weather combined with higher than average wind velocities have the potential to generate more dust.

Construction activities that are considered to be the most significant potential sources of fugitive dust emissions include:

- site clearance
- site preparation
- excavation.

Fugitive dust arising from construction phase activities is mainly of a particle size greater than the PM_{10} fraction (the maximum particle size that can potentially affect human health), nonetheless construction-related activities may contribute to local PM_{10} concentrations. Appropriate dust control measures can be highly effective for controlling emissions from potentially dust generating activities identified above, and adverse effects can be significantly reduced or eliminated.

Fugitive dust emissions will likely increase as a result of construction activities, particularly due to earthworks and trackout[21]. Fugitive dust release can be strongly influenced by wind direction and speed. The typical wind direction in the area is north-westerly. Some residential receptors are located downwind of the site boundary, which could be impacted by fugitive dust release; however due to the distance to the receptors from the site it is considered unlikely. Furthermore, background PM_{10} concentrations are below 50% of the relevant standard. As such, the impact significance with respect to fugitive dust release from construction related activities is a **minor** adverse impact.

[21] 'Trackout' is solid material from a site that adheres or agglomerates on the exterior of a motor vehicle (including tires), then subsequently falls onto a paved public roadway.

5.7.1.1.4 Summary

Impact significance for the construction phase is summarised in Table 5-5.

Table 5-5 Summary of unmitigated potential impacts on air quality during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Site clearance, preparation, excavation and grading leading to potential increase in air emissions (exhaust)	Medium	Low	Minor	N
Site clearance, preparation, excavation and grading leading to a potential periodic increase in fugitive dust levels due to vehicle movements	Medium	Low	Minor	N

5.7.1.2 Pre-commissioning and commissioning phase

During pre-commissioning the potential impacts are considered to be temporary and similar to the construction phase potential impacts discussed in the sections above. There are no other distinct impacts related to this phase, compared to construction phase impacts.

Frequent flaring, start-up and shut-down activities are anticipated during the commissioning phase of the Project. However, the potential impacts are considered to be temporary and of the same significance as the operations phase impacts discussed in the sections below. There are no other distinct impacts related to this phase, compared to the construction or operations phase impacts.

Due to the temporary nature of the potential pre-commissioning impacts, no long-term residual effects are anticipated, therefore these impacts are not assessed further.

5.7.1.3 Operations phase

5.7.1.3.1 Baseline context and receptor sensitivity

As for the construction phase of the Project, the sensitivity of receptors has been rated **medium**.

5.7.1.3.2 Project aspects

All operations phase activities that generate atmospheric emissions (point source and fugitive), including both routine and non-routine activities.

5.7.1.3.3 Magnitude of potential impacts

Non-greenhouse gas emissions

The operation of the Pearl Petroleum KM250A Project will result in emissions from the sources shown in Table 5-6 below. In addition, there will be emissions from the pilot flares (high pressure – HP, low temperature - LT and low pressure - LP) and low-low pressure (LLP) flare. During non-routine operations at the plant, flaring through the HP and LP flares may occur; this would cause emissions that occur simultaneously with those from the point sources and LLP flare as well as full emissions from the HP and LP flares. Table 5-7 below presents design specifications of the flares assessed in this study.

Condensate storage tank vent gas will be sent to the LLP flare. Fairly continuous fugitive losses can be expected from the condensate tank at the plant. The condensate storage tank is fuel gas blanketed such that when the tank is filled the fuel gas in the vapour space of the tank is vented as the liquid level rises (tank filling) and when the liquid level falls (tank emptying) new fuel gas is fed to the tank under pressure control. The fuel gas in the tank will interact with the condensate in the tank such that the composition of the fuel gas changes as it absorbs some of the components from the condensate. The vented gas will comprise loss from condensate and blanketing gas. Condensate gas comprises primarily pentane (47%), methane (10%) and toxics, namely benzene and toluene. The fuel/blanket gas comprises primarily methane (89%) and other fuel gas fractions.

VOC emissions from the condensate tanker loading station are generated (approximately 1300 tonnes/year) primarily by residual tanker VOCs from previous loads that are displaced by the condensate during filling. Pearl Petroleum is considering various abatement measures, including flaring and a vapour recovery unit. These options will be further investigated during the detailed engineering phase of the Project. Either option will significantly decrease the risk of benzene exposure with regard to tanker loading station workers. Furthermore, once the condensate pipeline is put into operation, there will be no further need for condensate storage or tanker loading at the site. This will also reduce the risk of tanker accidents on the road from the KM site to end users.

Table 5-6 Point source specifications

SI No.	Source	Fuel	Number of units	Rating (MW)
1	Booster compressor	Gas	3	19.5
2	Sales gas compressor	Gas	4	28.1
3	Power generation turbine	Gas	5	20.25
4	Hot oil heater	Gas	1	67.73
5	Thermal oxidiser	Sour Gas	1	4.35

Table 5-7 Flare specifications

SI NO	Flare	Mass flared in unplanned condition (kg/hour)	Flare stack diameter (inches)	Flare stack height	Gas velocity (m/s)
1	HP flare (with LT flare)	521095	30	50	330
2	LP flare	14416	8	20	171.50
3	LLP flare	485	18	25	8.65

The impact on ambient air quality from the KM250A Project has been assessed through an atmospheric air dispersion modeling study (ADMS) of emissions from the point sources and flaring operations. Two scenarios were modeled in the ADMS, namely:

1. Scenario 1: Planned routine operations which would cause emissions from the point sources, pilot flares and LLP flare
2. Scenario 2: Planned non-routine conditions/plant upset condition which would cause emissions from the point sources (including the LLP flare), HP flare and LP flare.

The ADMS was carried out using the most recent update of the EPA-prescribed AERMOD modeling system, which is a steady state plume model that predicts dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and simple and complex terrain. AERMOD is used for a range of assessments, including simultaneous modeling of multiple emission sources and types (point, flare volume, area, open pit, line), varying of emissions across seasons, account for aerodynamic downwash and predicting concentrations in either gridded or discrete receptors. The main steps in performing the modelling study were:

1. Characterise emission sources for emission rates and source specifications, namely physical parameters such as stack diameter and height and emission parameters namely exit temperature and velocity.
2. Determine averaging periods based on applicable regulator standards
3. Process meteorological data, typically five years.
4. Characterise the site where the sources are located including any building information
5. Acquire and process terrain information
6. Perform model runs
7. Analyse results and compare results against ambient standards
8. Visualise results.

Assumptions associated with the air quality modelling are presented in Appendix 7 (Table A7.1 to A7.3).

Source characterisation

At this stage of the Project design, there is limited information available concerning the emission sources. The point sources modeled in the ADMS was characterised using data provided by the client, engineering assumptions and United States Environmental Protection Association (EPA) air pollutant (AP) emission factors. Table 5-8 below provides stack parameters for the point sources modeled in the ADMS.

Table 5-8 Point source stack parameters for modelling

Sl No.	Source	Stack height (m)	Stack diameter (m)	Exit velocity (m/s)	Stack temp (K)	NO_2 (g/s)	SO_2 (g/s)	CO (g/s)	PM_{10} (g/s)
1	Booster compressor	20	0.4064	6.39	823	0.89	0.08	0.23	0.02
2	Sales gas compressor	20	0.4064	6.9	823	0.97	0.09	0.25	0.02

Sl No.	Source	Stack height (m)	Stack diameter (m)	Exit velocity (m/s)	Stack temp (K)	NO_2 (g/s)	SO_2 (g/s)	CO (g/s)	PM_{10} (g/s)
3	Power generation turbine	20	0.4064	8.89	823	0.56	0.05	0.14	0.01
4	Hot oil heater	20	1.5	10.85	550	2.91	0.84	2.44	0.16
5	Thermal oxidiser	35	0.9	15.03	1255	0.68	141.38	0.17	0.01

Flares in AERMOD are modeled as point sources, as a specific flare option is not available in AERMOD. While EPA Screen provides for a flare option, this model is suitable only for screening purposes and not for refined modeling. EPA Screen has built-in algorithms to account for buoyancy from the calculated heat release

Building downwash

Building downwash refers to the effect that wind flowing around and over buildings can have on plume from stacks. EPA's Building Profile Input Programme (BPIP) is an algorithm used to determine downwash effects for single and multi-tiered buildings and structures. The following buildings have been assessed using BPIP (Figure 5-2):

1. Accommodation camp
2. Training center
3. Warehouse
4. LPG office
5. Laydown yard and warehouse
6. Drilling warehouse
7. Medical center.

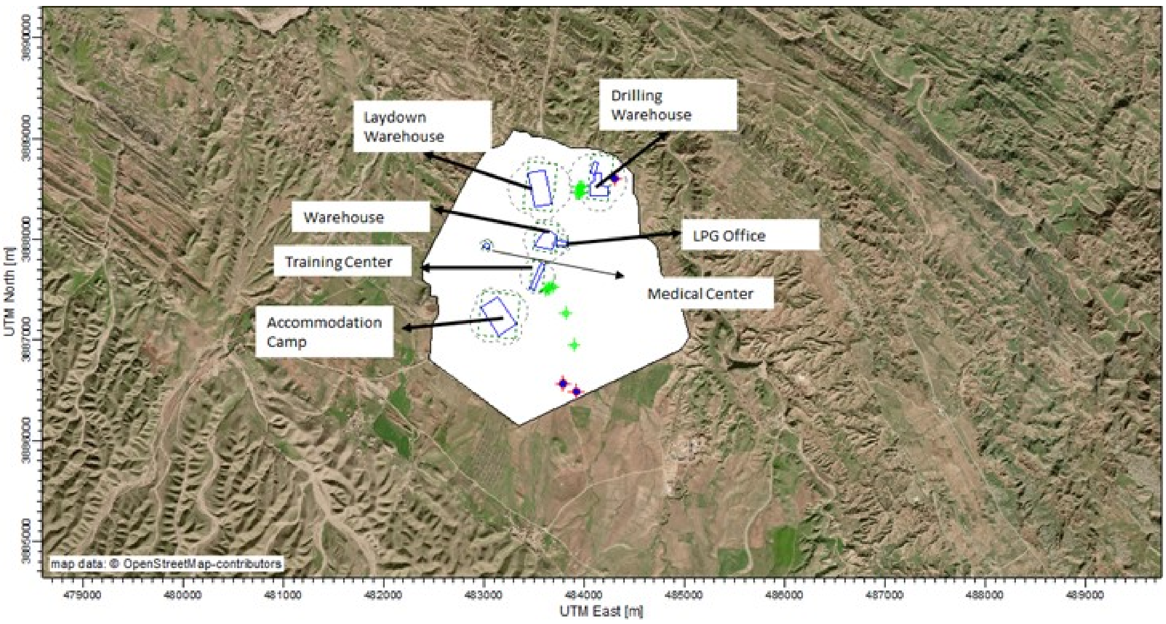

Figure 5-2 Buildings assessed in BPIP for downwash effects

Meteorological data

To perform the ADMS, Weather Research Forecast (WRF) prognostic data sets (2014-2018) for the Khor Mor site area processed using Mesoscale Model Interface Programme (MMIF) for AERMOD was obtained from Lakes Environmental, a certified meteorological data provider and processed using the Mesoscale Model Interface Programme (MMIF) for AERMOD. WRF data was preferred over Pearl Petroleum data (2012 to 2016) as WRF wind data is classified to a 36-point classification preferred for modeling (10 degrees) as opposed to a 16-point compass (22 degrees). Actual vector observations were also not recorded in the Pearl Petroleum data sets.

The WRF model is a next-generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications. WRF meteorological models provide for reliable and accurate predication when on-site real time hourly meteorological monitoring data is not available or not in a format suitable for use in AERMOD. Execution of the MMIF was carried out following the EPA recommendations in the document: *Guidance on the Use of the Mesoscale Modeling Interface Program (MMIF) for AERMOD Applications*.

Receptors

Sensitive receptors (see Table 5-9) used for this analysis are the same points at which baseline diffusion tube data was collected for various pollutants relevant to the KM250A Project (see Figure 3-5). Seven of these locations are villages within the KM250A Project air quality AOI. The eighth receptor is a key strategic location to the north of the site.

Table 5-9: List of sensitive receptors

Sl.No	Receptor ID	Location	Coordinates
1	MP1	Khor Mor Gawra	480777, 3887187
2	MP2	Awaye Jalal	483341, 3885132
3	MP3	Taza Shaher	485519, 3883077
4	MP4	Shekh Hameed	486766, 3881799
5	MP5	Khor Mor Bichuk	481840, 3886313
6	MP6	Mamisik	487404, 3887588
7	MP7	Qadir Karam	489432, 3894931
8	MP8	Key location	481604, 3890474

Model predictions and conclusions

Model runs were performed for NO_2, SO_2, CO and PM_{10} for Scenario 1 (normal or routine operations) and Scenario 2 (flaring operations which are considered non-routine). The findings and conclusions from the results are discussed below.

Model results for NO_2

The model runs were carried out for the 1-hour, 24-hour and annual averaging period. The results are provided in Table 5-10 through Table 5-12.

For the 1-hour averaging period, the model predictions show compliance to the Project Standard of 200 µg/m^3 at all sensitive receptors except at sensitive receptor MP5 (Khor

Mor Bichuk) in Scenario 1 and Scenario 2. The maximum offsite predicted concentration exceeds the Project Standard in both scenarios, however the 95th percentile concentration is below the Project Standard. Further analysis of the results shows that the incremental concentrations from unplanned flaring is within the ambient limits adopted by the Project.

For the 24-hour averaging period, the model predictions show compliance to the Project Standard of 94 µg/m³ in both scenarios. The maximum reported offsite concentration is also below the Project. standard for the annual averaging period, the model runs were performed only for routine operations (Scenario 1); the modelling results show compliance to the Project Standard of 40 µg/m³.

Representative dispersion isopleths are provided in Figure 5-3 to Figure 5-5.

Table 5-10 Model predictions for the 1-hour averaging period – NO_2

SI.No	Receptor ID	Location	Model predicted concentrations (µg/m³)		Project Standard (µg/m³)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	
1	MP1	Khor Mor Gawra	151.71	151.71	200
2	MP2	Awaye Jalal	55.78	55.78	
3	MP3	Taza Shaher	56.76	56.76	
4	MP4	Sheikh Hameed	21.48	21.48	
5	MP5	Khor Mor Bichuk	218.63	218.63	
6	MP6	Mamisik	73.07	73.07	
7	MP7	Qadir Karam	45.12	45.12	
8	MP8	Key location	65.22	65.22	
9	Maximum offsite concentration	-	372.68	372.68	
10	95th percentile offsite concentration		138.86	138.86	

Red – exceeds Project Standard

Table 5-11 Model predictions for the 24-hour averaging period – NO_2

SI No.	Receptor ID	Location	Model predicted concentrations (µg/m³)		Project Standard (µg/m³)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	
1	MP1	Khor Mor Gawra	15.64	15.64	94
2	MP2	Awaye Jalal	3.95	3.95	

Sl No.	Receptor ID	Location	Model predicted concentrations (µg/m^3)		Project Standard (µg/m^3)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	
3	MP3	Taza Shaher	2.83	2.83	94
4	MP4	Sheikh Hameed	1.37	1.38	
5	MP5	Khor Mor Bichuk	17.78	17.78	
6	MP6	Mamisik	14.15	14.25	
7	MP7	Qadir Karam	4.00	4.02	
8	MP8	Key location	10.92	10.93	
9	Maximum offsite concentration	-	65.83	65.86	

Red – exceeds Project Standard

Table 5-12 Model predictions for the annual averaging period – NO_2

Sl.No	Receptor ID	Location	Model predicted concentration (µg/m^3)	Baseline concentration (µg/m^3)	Cumulative impact (µg/m3)	Project Standard (µg/m^3)
			Routine operations (Scenario 1)			
1	MP1	Khor Mor Gawra	1.37	2.5	3.86596	40
2	MP2	Awaye Jalal	0.24	2.2	2.44269	
3	MP3	Taza Shaher	0.20	1.4	1.6037	
4	MP4	Sheikh Hameed	0.12	2.4	2.5189	
5	MP5	Khor Mor Bichuk	0.97	2.7	3.66703	
6	MP6	Mamisik	1.63	2.5	4.12611	
7	MP7	Qadir Karam	0.14	2.5	2.64379	
8	MP8	Key location	1.09	4.6	5.68966	
9	Maximum offsite concentration	-	4.35	-	4.34667	

Red – exceeds Project Standard

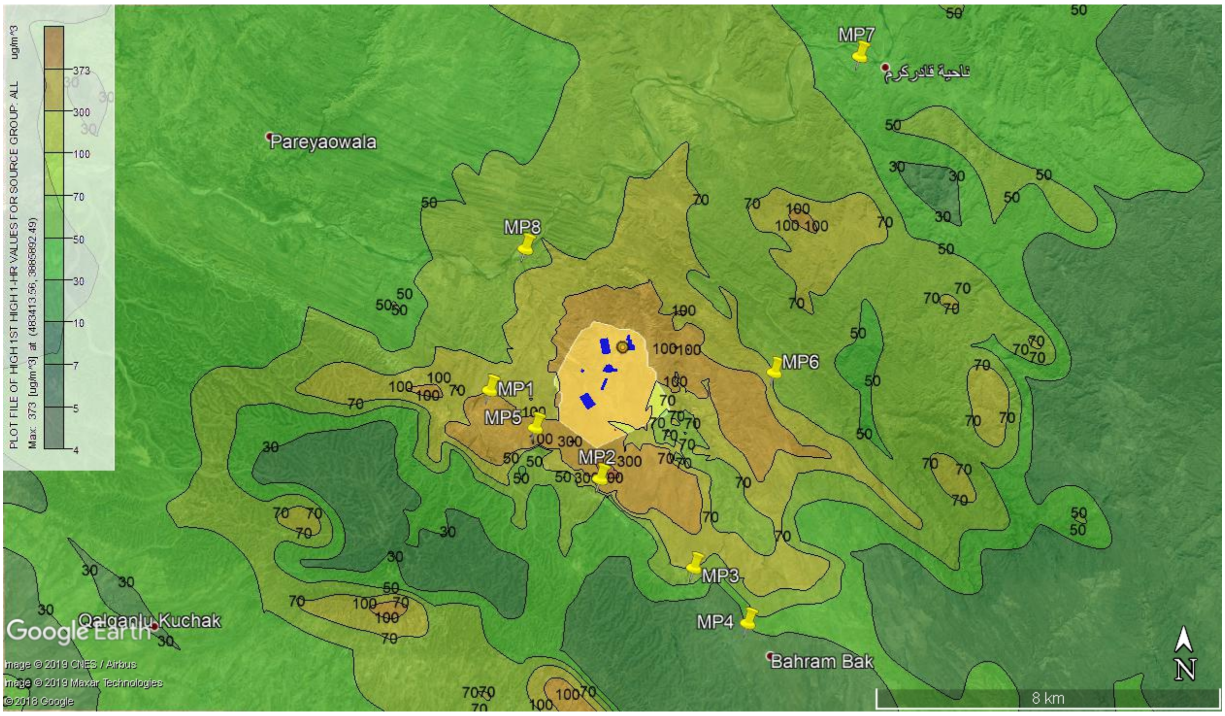

Figure 5-3 Model predictions for 1-hour averaging period (Scenario 2) - NO_2

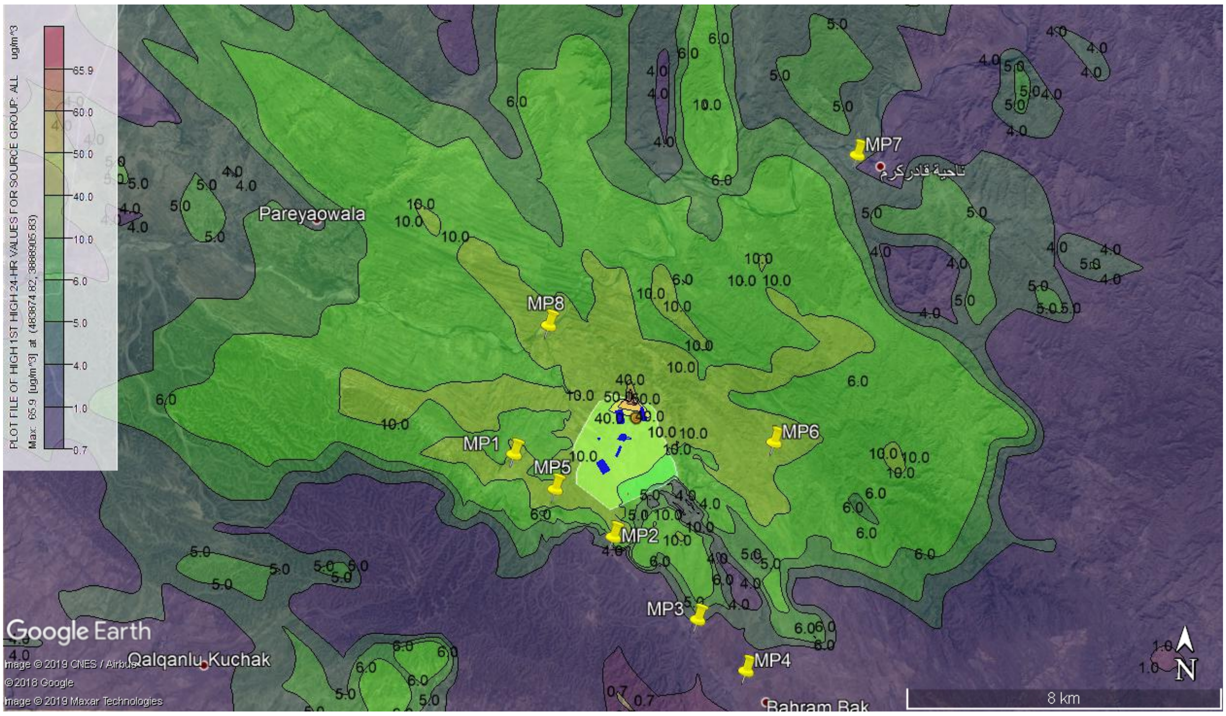

Figure 5-4 Model predictions for 24-hour averaging period (Scenario 2) - NO_2

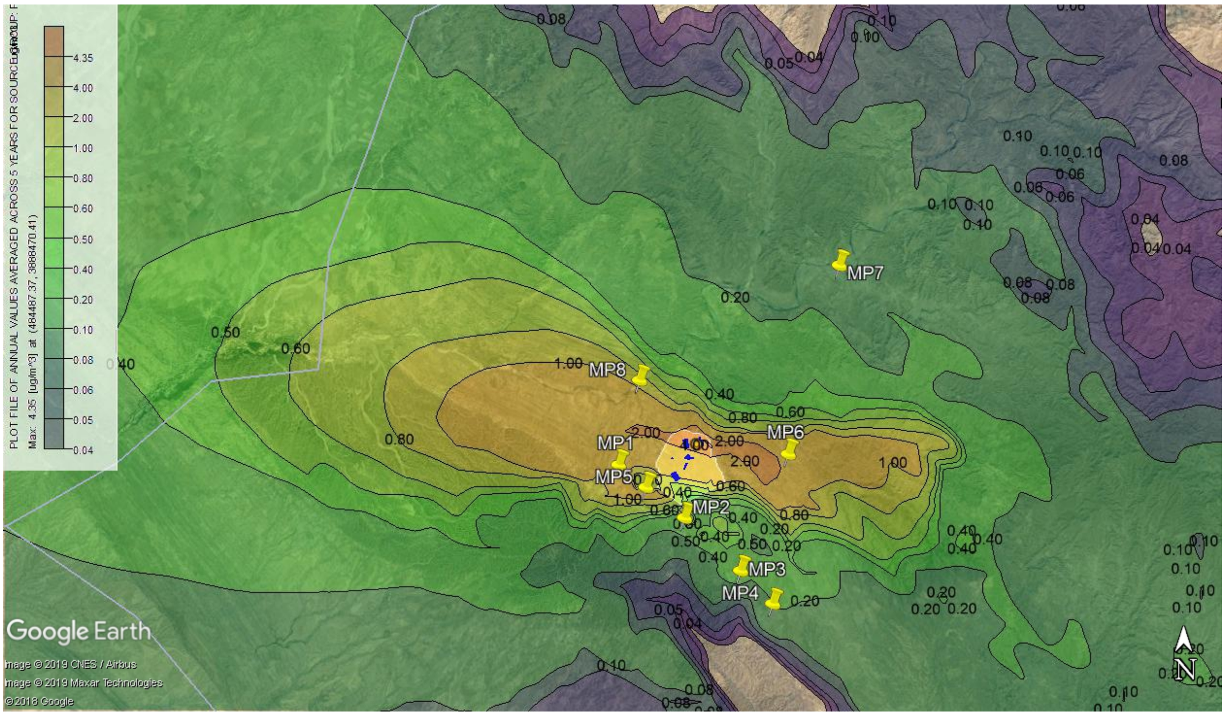

Figure 5-5 Model predictions for annual averaging period - NO_2

Model results for SO_2

The model runs were carried out for the 1-hour, 3-hour, 24-hour and annual averaging period. The results are provided in Table 5-13 to Table 5-16. The results are as follows

- For the 1-hour averaging period, the model predictions show exceedance of the Project Standard of 262 µg/m3 at all sensitive receptors except at MP6 (Mamisik) and MP7 (Qadir Karam) in Scenario 1 and Scenario 2.
- For the 3-hour averaging period, the model predictions show compliance to the Project Standard of 262 µg/m3 at all sensitive receptors in both scenarios except at MP2 (Awaye Jalal). The maximum reported offsite concentration exceeds the Project Standard.
- For the 24-hour averaging period, the model predictions show compliance with the interim limit (Appendix 3, Table A3-6) at all sensitive receptors. The maximum reported offsite concentration exceeds the interim limit, however, the 95th percentile concentration is below the interim limit.
- For the annual averaging period, the model predictions show compliance with the interim limit at all sensitive receptors. The maximum reported offsite concentration shows compliance with the interim limit in the cumulative assessment, when concentrations reported in the baseline survey are added to the model predictions.

Analysis of the results show that the exceedance is caused by SO_2 emissions from the thermal oxidiser.

Representative dispersion isopleths are provided in Figure 5-6 to Figure 5-9.

Table 5-13 Model predictions for the 1-hour averaging period – SO_2

Sl.No	Receptor ID	Location	Model predicted concentrations (µg/m³)			Project Standard (µg/m³)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	Thermal oxidiser alone	
1	MP1	Khor Mor Gawra	398.88	398.88	397.15	262
2	MP2	Awaye Jalal	1750.86	1750.80	1746.20	
3	MP3	Taza Shaher	742.16	742.16	738.45	
4	MP4	Sheikh Hameed	618.25	618.24	618.24	
5	MP5	Khor Mor Bichuk	523.89	523.88	523.54	
6	MP6	Mamisik	242.04	242.03	240.99	
7	MP7	Qadir Karam	166.31	166.27	164.96	
8	MP8	Key location	350.25	350.25	348.88	
9	Maximum offsite concentration	-	2563.12	2563.12	2563.12	
10	95th percentile offsite concentration	-	638.20	638.20	638.20	

Red – exceeds Project Standard

Table 5-14 Model predictions for the 3-hour averaging period – SO_2

Sl.No	Receptor ID	Location	Model predicted concentrations (µg/m³)			Project Standard (µg/m³)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	Thermal oxidiser alone	
1	MP1	Khor Mor Gawra	196.72	196.72	194.07	262*
2	MP2	Awaye Jalal	810.72	810.73	808.79	
3	MP3	Taza Shaher	247.47	247.48	246.24	
4	MP4	Sheikh Hameed	207.20	207.21	206.28	
5	MP5	Khor Mor Bichuk	204.35	204.35	204.35	

Sl.No	Receptor ID	Location	Model predicted concentrations (µg/m³)			Project Standard (µg/m³)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	Thermal oxidiser alone	
6	MP6	Mamisik	165.81	165.81	164.83	262
7	MP7	Qadir Karam	57.88	57.94	57.41	
8	MP8	Key location	128.19	128.19	126.75	
9	Maximum offsite concentration	-	1753.78	1753.78	1753.78	
10	95th percentile offsite concentration	-	327.00	327.00	327.00	

Red – exceeds Project Standard

* The Government of Iraq (GoI) ambient air quality standard for SO_2 at an averaging period of 1-hour is stricter than the KRG's standard at an averaging period of 3-hours. It is standard practice for ambient air quality standards to be less strict at shorter averaging periods. Therefore, the GoI standard for SO_2 at an averaging period of 1-hour is set as the Project Standard for both 1-hour and 3-hours.

Table 5-15 Model predictions for the 24-hour averaging period – SO_2

Sl.No	Receptor ID	Location	Model predicted concentrations (µg/m³)			Project Standard (µg/m³)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	Thermal oxidiser alone	
1	MP1	Khor Mor Gawra	38.69	38.70	37.79	20 (interim limit 125)
2	MP2	Awaye Jalal	102.72	102.73	102.47	
3	MP3	Taza Shaher	33.27	33.29	33.05	
4	MP4	Sheikh Hameed	31.32	31.34	31.20	
5	MP5	Khor Mor Bichuk	49.63	49.66	49.52	
6	MP6	Mamisik	27.78	27.90	27.42	
7	MP7	Qadir Karam	7.55	7.57	7.35	
8	MP8	Key location	33.09	33.09	32.58	
9	Maximum offsite concentration	-	490.00	490.01	489.96	
10	95th percentile offsite concentration	-	77.16	77.16	--	

Red – exceeds interim limit

Table 5-16 Model predictions for the annual averaging period – SO_2

I.No	Receptor ID	Location	Model predicted concentrations (µg/m^3)		Project Standard (µg/m^3)
			Routine operations (Scenario 1)	Thermal oxidiser alone	
1	MP1	Khor Mor Gawra	4.04	3.89	20 (interim limit 125)
2	MP2	Awaye Jalal	4.68	4.64	
3	MP3	Taza Shaher	1.85	1.83	
4	MP4	Sheikh Hameed	2.49	2.48	
5	MP5	Khor Mor Bichuk	8.68	8.52	
6	MP6	Mamisik	2.01	1.86	
7	MP7	Qadir Karam	0.37	0.36	
8	MP8	Key location	1.34	1.24	
9	Maximum offsite concentration	-	47.0	46.94	

Red – exceeds interim limit

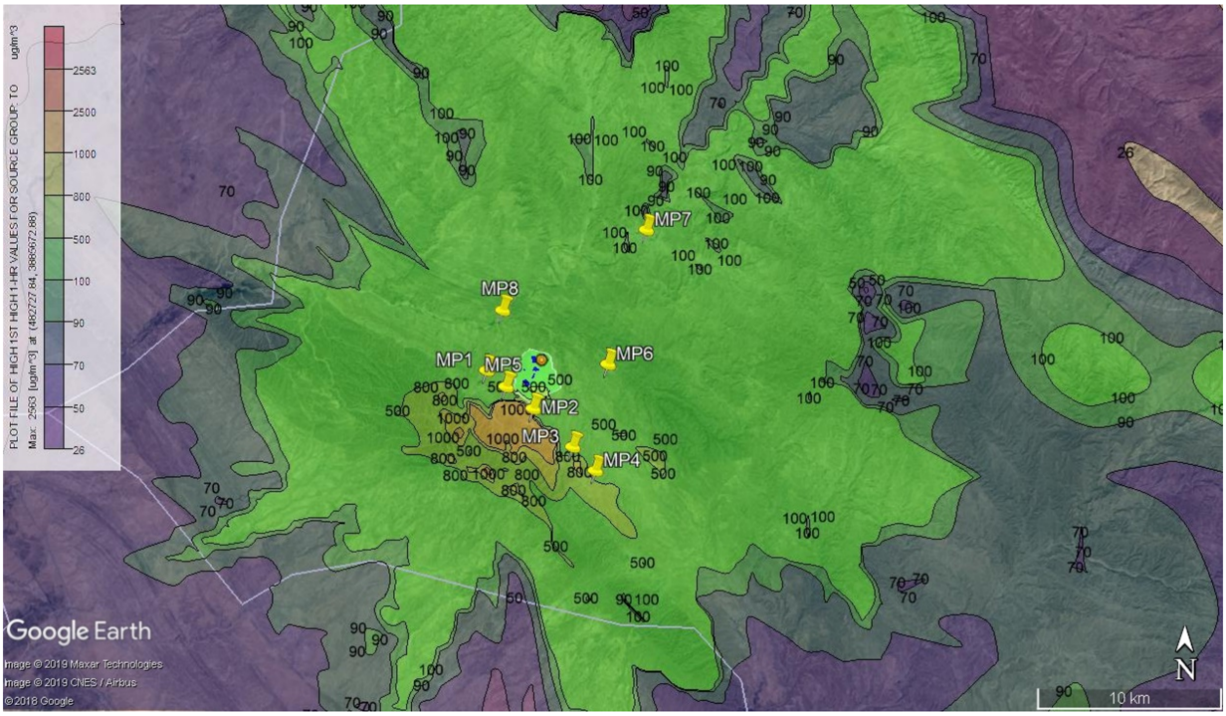

Figure 5-6 Model predictions for 3-hour averaging period (thermal oxidiser) – SO_2

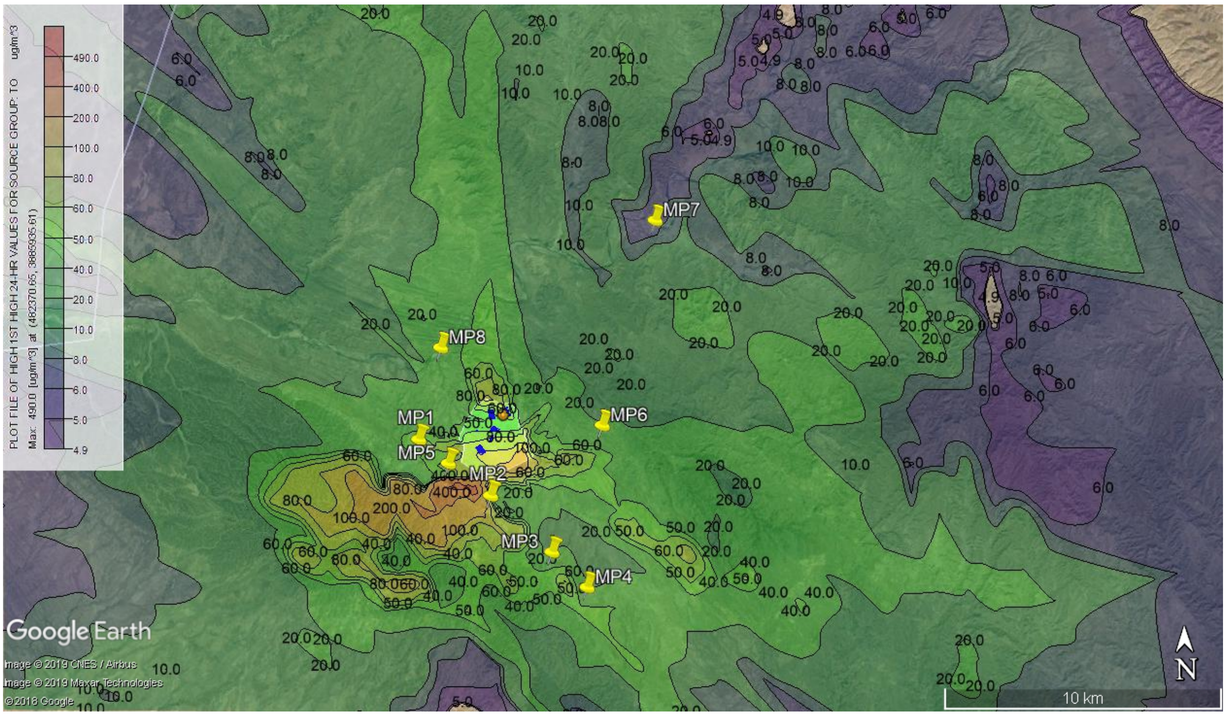

Figure 5-7 Model predictions for 1-hour averaging period (thermal oxidiser) – SO_2

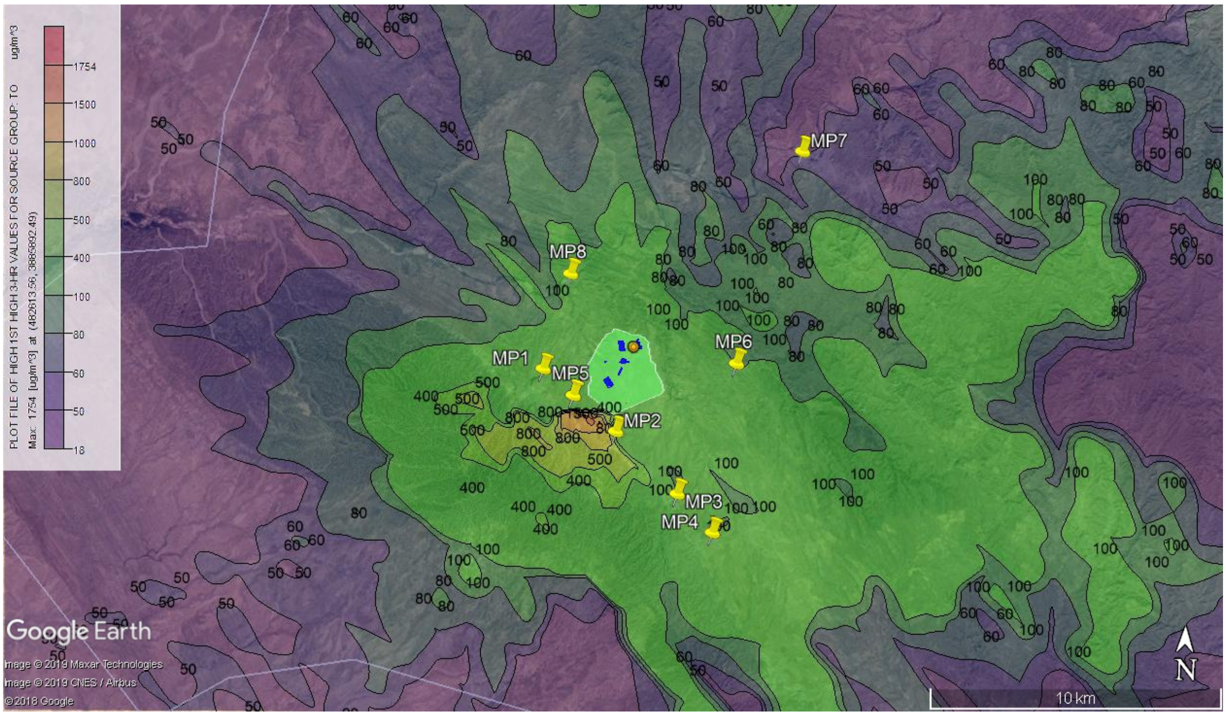

Figure 5-8 Model predictions for 24-hour averaging period (thermal oxidiser) – SO_2

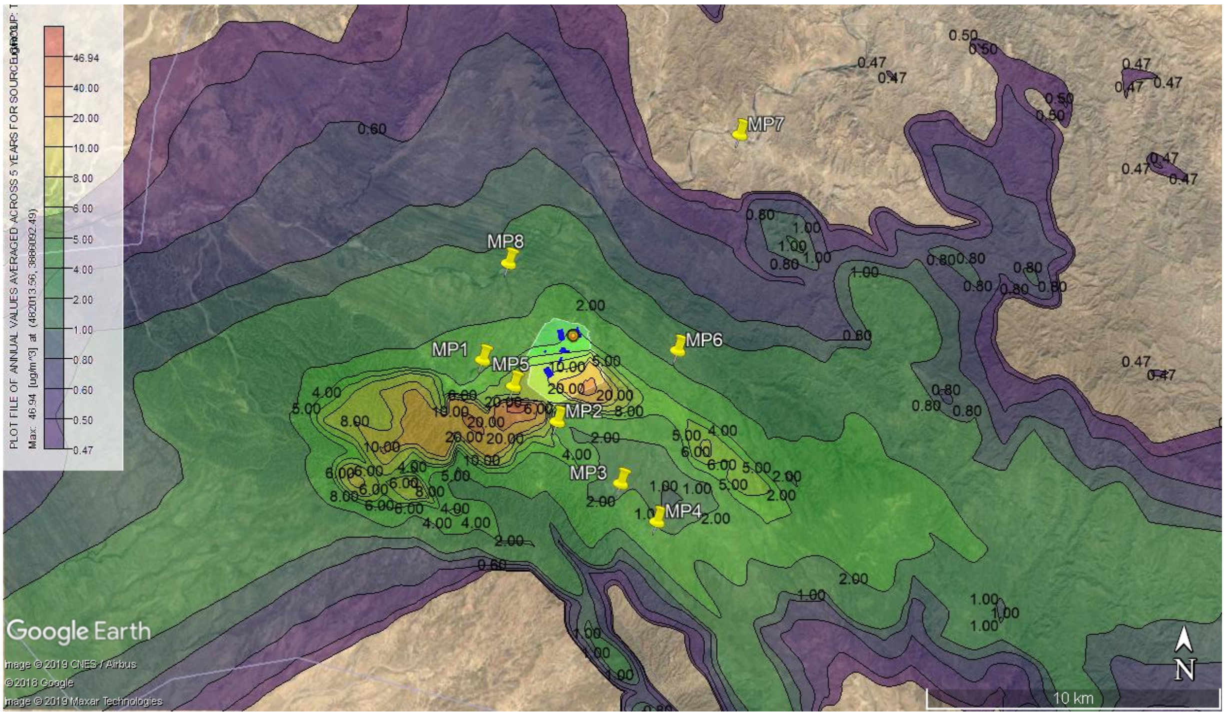

Figure 5-9 Model predictions for annual averaging period (thermal oxidiser) – SO_2

Model results for CO

The model runs were carried out for the 1-hour and 8-hour averaging period. The results are provided in Table 5-17 and Table 5-18. The results are as follows

- For the 1-hour averaging period, the model predictions show exceedance of the Project Standard of 34.368 µg/m^3 at MP1 (Khor Mor Gawra) and MP5 (Khor Mor Bichuk) in Scenario 1 and Scenario 2. The maximum reported offsite concentration also exceeds the Project Standard.
- For the 8-hour averaging period, the model predictions show compliance to the Project Standard of 10,310 µg/m^3 at all sensitive receptors in both scenarios.

A representative isopleth is provided in Figure 5-10.

Table 5-17 Model predictions for the 1-hour averaging period – CO

Sl.No	Receptor ID	Location	Model predicted concentrations (µg/m^3)		Project Standard (µg/m^3)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	
1	MP1	Khor Mor Gawra	39.15	39.15	34.368
2	MP2	Awaye Jalal	30.67	30.67	
3	MP3	Taza Shaher	20.25	20.34	
4	MP4	Sheikh Hameed	13.81	13.81	

Sl.No	Receptor ID	Location	Model predicted concentrations (µg/m^3)		Project Standard (µg/m^3)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	
5	MP5	Khor Mor Bichuk	56.17	56.17	
6	MP6	Mamisik	18.85	18.86	
7	MP7	Qadir Karam	11.63	11.63	
8	MP8	Key location	16.83	16.83	
9	Maximum offsite concentration	-	96.27	96.27	

Red – exceeds Project Standard

Table 5-18 Model predictions for the 8-hour averaging period – CO

Sl.No	Receptor ID	Location	Model predicted concentrations (µg/m^3)		Project Standard (µg/m^3)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	
1	MP1	Khor Mor Gawra	11.17	11.17	10,310
2	MP2	Awaye Jalal	4.63	4.77	
3	MP3	Taza Shaher	4.12	4.49	
4	MP4	Sheikh Hameed	2.69	4.14	
5	MP5	Khor Mor Bichuk	13.67	13.67	
6	MP6	Mamisik	9.89	9.90	
7	MP7	Qadir Karam	3.01	3.50	
8	MP8	Key location	7.00	7.00	
9	Maximum offsite concentration	-	30.92	30.95	

Red – exceeds Project Standard

10,310 µg/m^3 = 9 ppm

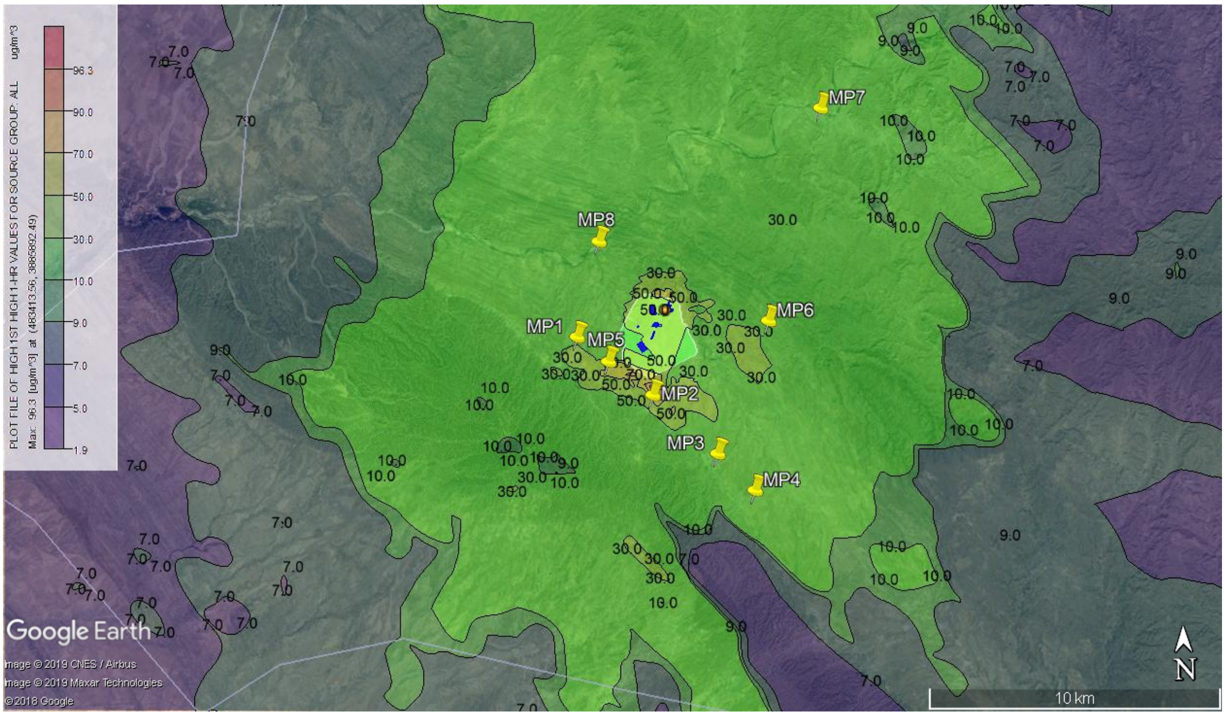

Figure 5-10 Model predictions for 1-hour averaging period – CO

Model Results for PM_{10}

The model runs were carried out for the 24-hour and annual averaging period. The results are provided in Table 5-19 and Table 5-20. The model results show compliance to the Project Standards at all sensitive receptors. The maximum reported offsite concentration is also below the Project Standard.

A representative isopleth is provided in Figure 5-11.

Table 5-19 Model predictions for the 24-hour averaging period – PM_{10}

Sl.No	Receptor ID	Location	Model predicted concentrations (µg/m^3)		Project Standard (µg/m^3)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	
1	MP1	Khor Mor Gawra	0.33	0.33	50
2	MP2	Awaye Jalal	0.16	0.24	
3	MP3	Taza Shaher	0.09	0.23	
4	MP4	Sheikh Hameed	0.06	0.22	

Sl.No	Receptor ID	Location	Model predicted concentrations (µg/m³)		Project Standard (µg/m³)
			Routine operations (Scenario 1)	Non-routine operations (Scenario 2)	
5	MP5	Khor Mor Bichuk	0.37	0.37	
6	MP6	Mamisik	0.30	0.37	
7	MP7	Qadir Karam	0.09	0.19	
8	MP8	Key location	0.23	0.24	
9	Maximum offsite concentration	-	1.44	1.47	

Red – exceeds Project Standard

Table 5-20 Model predictions for the annual averaging period – PM_{10}

Sl.No	Receptor ID	Location	Model predicted concentrations (µg/m³)	Project Standard (µg/m³)
			Routine operations (Scenario 1)	
1	MP1	Khor Mor Gawra	0.04	20
2	MP2	Awaye Jalal	0.02	
3	MP3	Taza Shaher	0.02	
4	MP4	Sheikh Hameed	0.02	
5	MP5	Khor Mor Bichuk	0.05	
6	MP6	Mamisik	0.06	
7	MP7	Qadir Karam	0.02	
8	MP8	Key location	0.04	
9	Maximum offsite concentration	-	0.11	

Red – exceeds Project Standard

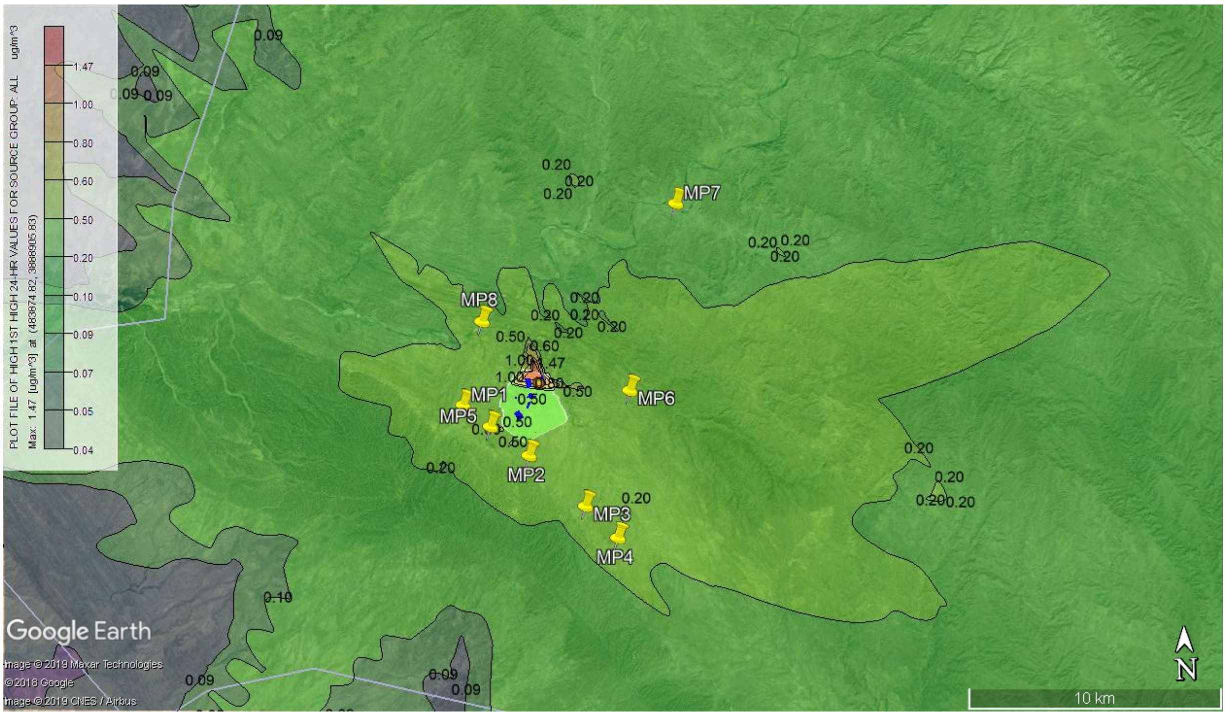

Figure 5-11 Model predictions for 24-hour averaging period – PM_{10}

When the facility is in operation, small quantities of non-combusted hydrocarbons may escape as fugitive emissions from pipe flanges, valves, compressors and pumps.

Vehicles operating at the site during operations and delivering supplies to the site or carrying out inspections along the pipeline routes will run on diesel fuel and will emit exhaust gases.

Impact significance rating

Although there is an existing source of air emissions in this area (the existing Khor Mor gas plant), baseline data indicate that the operations phase AOI for air quality (up to 10 km from the main Project site during routine operations) is generally un-degraded (with the exception of SO_2).The magnitude of NO_2 during routine operations phase activities within the expected AOI has been rated as **high** in relation to the 1-hour limit at one or more sensitive receptors. The magnitude in relation to the 24-hour and annual limits are rated as **slight**. The overall (worst case) impact magnitude rating is therefore rated as **high** (see Table 5-21 below).

Fugitive VOC emissions can be expected from tanker truck condensate loading activities. Vented gas will comprise pentane (21%), hexane (22%) and toxics such as benzene and toluene. Emissions could occur from operation of any of the nine tanker loading bays (eight working, one standby). A vapor extraction system with design capacity of 750 Am^3/hour[22] will be included to minimize fugitive losses. Extracted vapor will be vented and will be diluted with forced air. KM250A Project studies (Hatch, 2019i, 2019u, 2019v) suggest a minimum stack height of 10 m to limit occupational exposure.

[22] Am^3 is gas volume in m^3 at the actual operating conditions of the process.

The impact magnitude of SO_2 emissions is rated as **high** in relation to the 1-hour, 3-hour and 24-hour limits, and medium for the annual limit. The worst-case magnitude is therefore rated as **high**. The impact magnitudes for CO and PM10 are rated as **slight**.

Summary of conventional emissions

A summary of unmitigated potential impacts on air quality during the KM250A Project operations phase is presented in Table 5-21. The results above indicate that the difference in ground level concentration between Scenario 1 and Scenario 2 are negligible for all polluting parameters. Therefore, only one impact rating is presented for each polluting parameter.

Table 5-21 Summary of unmitigated potential impacts on air quality during operation

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Emissions from routine or non-routine operations of the gas plant leading to increase in NO_2 ambient ground level concentrations	High	Medium	High	Y
Emissions from routine or non-routine operations of the gas plant leading to Increase in SO_2 levels in ambient air	High	Medium	High	Y
Emissions from routine or non-routine operations of the gas plant leading to increase in CO levels in ambient air	Slight	Medium	Slight	N
Emissions from routine or non-routine operations of the gas plant leading to increase in PM_{10} levels in ambient air	Slight	Medium	Slight	N

5.7.1.3.4 Greenhouse gas emissions

Current total carbon dioxide (tCO_2) emissions (from the existing KM facility) covering both Scope 1 and Scope 2[23] have been separately calculated (PwC, 2018). In 2017, ongoing operations produced around 120,000 tCO_2 of Scope 1 emissions. This constitutes a 53% decrease from the operations' 2013 Scope 1 emissions and a 10% decrease compared to the 2016 figure. For Scope 2, operations produced around 800 tCO_2 in 2017, which is an 8% decrease from emissions in 2013 and a 7% decrease from emissions in 2016.

A preliminary estimate of GHG emissions due to KM250A Project operations was based only on gas plant activities (GHG emissions associated with offsite buildings are not included, and electricity will not be purchased from the national grid). The main sources of GHG emissions are as follows:

- power generation
- hot oil system
- flaring (occasional for the HP and LP flares, and continuously for the LLP flare)
- thermal oxidiser: 60% of KM500 values.

[23] Scope 1 concerns direct GHG emissions from site sources that are controlled by Pearl Petroleum. Scope 2 concerns indirect GHG emissions that are emitted in the generation of electricity.

The contribution of VOCs has been excluded.

The estimated GHG emissions for the KM250A Project are presented in Table 5-22.

Table 5-22 Estimate of GHG emissions during KM250A operations

Source	Emissions rate (tCO_{2e}/year)			
	Power generation – gas engine	Hot oil heater(s)	Flare (HP/LT, LP)	Thermal oxidiser
CO_2	18,441	55,869	1,995	7,714
methane	1,060	30	0	0
NO_2	0	79	0	0
Total	19,051	55,978	1,995	7,714

Note: NO_2 is not a GHG; it contributes to the creation of atmospheric ozone
tCO_2 – total carbon dioxide

KM250A Project operations phase gas plant GHG emissions are likely to be largely neutralised by the reduction of high-carbon diesel for relatively low-carbon gas at Kurdistan power plants as a result of the Project. The net impact of the Project with respect to GHG emissions is therefore **positive**. More precision will be obtained during the construction phase of the Project once equipment is specified.

Summary of greenhouse gas emissions

A summary of unmitigated potential impacts of GHG emissions during operations presented in Table 5-23.

Table 5-23 Summary of unmitigated potential impacts of GHG emissions during operations

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Operation of gas train leading to potential decrease in GHG emissions from regional power plants due to substitution of KM250A sales gas for current diesel fuel at those installations	Positive	Medium	Positive	N

5.7.1.4 Decommissioning phase

The expected impacts of decommissioning are considered to be similar to the construction phase, especially concerning the use of moving and non-moving equipment (see Section 5.7.1.1). The only distinct impacts related to this phase, compared to construction or operations phase impacts, concern possible release of VOCs from disposal of liquid hydrocarbons remaining in vessels and piping at the site, and disposal of major pieces of equipment. These impacts must be re-evaluated once a Decommissioning Plan is developed.

5.7.2 Soil

5.7.2.1 Construction phase

5.7.2.1.1 Baseline context and receptor sensitivity

The sensitivity of the soil along the flowline rights of way is **medium**. This sensitivity is based on the presence of steppe grassland within the flowline corridors which is not used for crop cultivation and is used for grazing in some areas. The sensitivity of soil within the KM site fenceline is **low.**

5.7.2.1.2 Project aspects

Construction activities that have the potential to cause direct or indirect impacts on soil quality include, but are not limited to:

- site vegetation clearing and topsoil stripping
- grading, levelling and compacting
- excavation for foundations, sub-structures and safety ditch
- trenching activities for buried flowlines and cables (power and fibre optic)
- backfilling and reinstatement
- pavement laying and installation of structures
- storage and handling of hazardous waste/materials, sewage sludge, and oils, lubricants and chemicals, as well as refuelling and maintenance activities of machinery, equipment and vehicles
- storage and handling of large quantities of fuel required for operation of machinery, equipment and vehicles
- use of temporary sanitary facilities.

5.7.2.1.3 Magnitude of potential impacts

The Project aspects cited above_have the potential to lead to the following impacts on soils:

- localised soil erosion
- compaction and topsoil loss
- changes to the existing topography and drainage patterns
- potential increased risk of contamination due to loss of containment of fuel storage tanks
- potential increased risk of contamination due to improper storage or handling of hazardous waste/materials, sewage sludge and oils, lubricants and chemicals.

Loss of land/soils used for agriculture

The soil AOI was designated as the physical footprint of the Project at the main Project site and along the new flowline corridors (see Section 3.2.3.1). Potential impacts on soil during construction of the gas plant would occur due to soil compaction, increased susceptibility of the soils to wind and water erosion, contamination of soils with petroleum products, loss of topsoil productivity, increased desertification and disturbance of biological soil crusts.

The soil within the plant footprint area is not used for agriculture so no further assessment of this potential impact is required. Installation of the flowlines (described in Section 2.5.5) will cause the most significant impact on soils due to the high level of physical disturbance during excavation, grading, trenching, backfilling and restoration activities. The magnitude is low given that it is understood that the areas crossed by the routes are not used for agriculture, and the sensitivity is medium given that the land is used for grazing. The pre-mitigation impact significance is **minor**.

Reduced soil quality

Accidental releases of chemicals, fuels, wastewater and other construction wastes on land within the plant footprint area will pose a localised effect on the soil quality. Leaks and spills will be contained within the construction areas. The magnitude is rated **low** given the likely extent and duration. Without mitigation, the impacts are expected to be **slight**.

The primary risk of a release is through a spill by a tanker carrying condensate offsite (the point of sale is at the Khor Mor site fenceline; tankers will be operated by an independent party under MNR oversight). Furthermore, there is potential for the use of the Jambur condensate pipeline pending discussions between the KRI and the federal Iraq government. This would reduce risk posed by transport of condensate by tanker truck.

5.7.2.1.4 Summary

The impact significance is presented in Table 5-24 below.

Table 5-24 Summary of unmitigated potential impacts on soil during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Ground excavation for flowlines leading to loss of land/soils	Low	Medium	Minor	N
Storage and handling of fuels, chemicals and waste leading to reduction in soil quality	Low	Low	Slight	N

5.7.2.2 Pre-commissioning and commissioning phase

5.7.2.2.1 Baseline context and receptor sensitivity

The sensitivity of the soil along the flowline rights of way is **medium**. This sensitivity is based on the presence of steppe grassland within the flowline corridors which is not used for crop cultivation and is used for grazing in some areas.

5.7.2.2.2 Project aspects

Pre-commissioning activities that have the potential to cause direct or indirect impacts on soil quality include flowline hydrotesting and discharge of hydrotest water. Following construction, all flowlines will be hydrotested so that any leaks can be identified and repaired (a planned activity). Hydrotest water will be treated with biocide and oxygen scavenger to inhibit corrosion and its pH adjusted with caustic soda and buffered with bicarbonate.

5.7.2.2.3 Magnitude of potential impacts

Hydrotest water will not be discharged to ground unless it meets the required Iraqi discharge standards (Appendix 3, Table A.3-2). Depending on quality, leaks or unplanned releases of water used for flowline hydrotesting to the ground may cause local contamination and alter the characteristics of the soil and groundwater. The magnitude is **low** given the short duration and local extent of potential impact and the sensitivity of soil along the flowlines is medium. Without mitigation, this has the potential to have a **minor** impact on soil. However, hydrotest water will not be discharged by soakaway unless it meets the appropriate standards.

5.7.2.2.4 Summary

A summary of unmitigated potential KM250A Project pre-commissioning and commissioning impacts on soil is presented in Table 5-25.

Table 5-25 Summary of unmitigated potential impacts on soil during pre-commissioning and commissioning

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Leaks and discharge of hydrotesting water to ground leading to soil contamination	Low	Medium	Minor	N

5.7.2.3 Operations phase

5.7.2.3.1 Baseline context and receptor sensitivity

As for the operations phase of the Project, the sensitivity of the soil in the Project operation areas is **low** given that the land is not intended for agricultural use.

5.7.2.3.2 Project aspects

Gas plant operations have the potential to result in the following impacts on soils:

- potential increased risk of contamination due to improper storage or handling of fuels, hazardous waste/materials, sewage sludge and oils, lubricants and chemicals
- potential increased risk of contamination due to loss of containment of condensate during transportation, custody of condensate will be passed over to the KRG/MNR, who will be responsible for providing tanker trucks, at the fenceline).

5.7.2.3.3 Magnitude of potential impacts

The potential impacts on soil quality during the operations phase within the plant area typically relate to unplanned leaks and spills of fuel, chemicals and waste (hazardous materials). The magnitude is **slight** and thus could give rise to **slight** impacts on soils within the site area.

Operation of the buried flowlines are expected to have no impact on soil during routine planned operations.

Stormwater run-off from the Project gas plant site could result in localised soil contamination if runoff is contaminated with hydrocarbons (for example). As a built-in design measure the ground surface at the condensate tanker loading area, the condensate transfer pump and storage tanks will be concrete paved and include sumps with gratings to collect leaks and sized to collect first 25 mm of the rainfall from the area. The hydrocarbon-affected water or leaks will be drained to storage tanks for further treatment and disposal. Suitable valve chambers will be provided to prevent accidental spillage of produced fluids into the storm water drainage.

All access roads within the facility will be asphalt concrete or cement concrete paved (except for the perimeter access road that will be unpaved). The area will be graded in slope to have natural storm water flow towards natural storm drainage area. Gutter systems will be constructed in such a manner that water should not pond on the roadway or flow at random over fill slopes. The magnitude of this impact is **slight** (localised extent and infrequency) and sensitivity of the soil is **low**, and thus the significance is **slight**.

5.7.2.3.4 Summary

A summary of unmitigated potential KM250A Projects operations phase impacts on soil is presented in Table 5-26.

Table 5-26 Summary of unmitigated potential impacts on soil during operations

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Storage and handling of fuels, chemicals and waste leading to soil contamination	Slight	Low	Slight	N

5.7.2.4 Decommissioning phase

5.7.2.4.1 Baseline context and receptor sensitivity

As for the decommissioning phase of the Project, the sensitivity of the soil in the areas outside of the Khor Mor fenceline (that is, the flowline rights of way, where there is some grazing and a number of water wells) is **low**.

5.7.2.4.2 Project aspects

Decommissioning phase activities with the potential to impact soil quality include:

- dismantling of equipment and infrastructure
- machinery and vehicle operations, including refuelling
- use of temporary sanitary facility for site workers
- transport and removal of hazardous materials
- fuel storage and vehicle maintenance.

These activities may cause possible leakage or spills of liquids on soil. A Decommissioning Plan will be produced which may include the removal of hydrocarbons, decommissioning of production equipment and removal of modules, substructures and equipment, and their transport for disposal or reuse. The decommissioning procedures will reflect applicable MNR laws and regulations in place at the time, and if correctly managed, physical disturbance of soil associated with dismantling of equipment and infrastructure is not considered to require further assessment.

5.7.2.4.3 Magnitude of potential impacts

The potential for leaks or spills is considered to have a significance of **slight** given the **slight** magnitude (limited duration and localised extent) and **low** sensitivity of the soil.

5.7.2.4.4 Summary

A summary of unmitigated potential KM250A Project decommissioning phase impacts on soil is presented in Table 5-27.

Table 5-27 Summary of unmitigated potential impacts on soil during decommissioning

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Storage and handling of fuels, chemicals and waste leading to soil contamination	Slight	Low	Slight	N

5.7.3 Water resources

5.7.3.1 Construction phase

5.7.3.1.1 Baseline context and receptor sensitivity

Groundwater is the most important source of public water supply to the local communities and therefore the sensitivity of groundwater in the AOI is **high**.

5.7.3.1.2 Project aspects

The main Project activities with possible impacts on groundwater are groundwater abstraction and storage and handling of hazardous substances.

5.7.3.1.3 Magnitude of potential impacts

Abstraction of groundwater leading to aquifer drawdown

There are several existing groundwater abstraction wells and springs in the AOI. During the construction phase water for dust suppression alone will require an estimated 43,200 m^3 over four months (see Section 2.7.1). Water will also be consumed by workers (drinking and sanitary). The abstraction of groundwater to supply construction activities therefore has the potential to have a direct impact on the water table through drawdown, which may reduce the yield of nearby boreholes and wells, and therefore the magnitude is ranked as **medium**. The unmitigated significance is **high**.

Reduced groundwater quality

Potential impacts to the quality of groundwater within the AOI may arise during construction due to the improper storage and handling, or loss of containment, of fuels, sewage sludge, and oils, lubricants and chemicals. Such impacts may also arise due to refuelling and maintenance activities of machinery, equipment and vehicles, . Impacts to groundwater quality could occur through leaching of contaminants from the soil to shallow groundwater The magnitude of this impact is likely to be **low** (limited extent and duration) and the sensitivity of the groundwater receptor is **high** as explained above. Without mitigation, this could give rise to **moderate** impacts.

5.7.3.1.4 Summary

A summary of unmitigated potential KM250A Project construction phase impacts on water resources is presented in Table 5-28.

Table 5-28 Summary of unmitigated potential impacts on water resources during construction

Aspect	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Groundwater abstraction leading to aquifer drawdown	Medium	High	High	Y
Storage and handling of fuels and chemicals leading to leaks/spills and reduced groundwater quality	Low	High	Moderate	Y

5.7.3.2 Pre-commissioning and commissioning phase

5.7.3.2.1 Baseline context and receptor sensitivity

Groundwater is the most important source of public water supply to the local communities and therefore the sensitivity of groundwater in the AOI is **high**.

5.7.3.2.2 Project aspects

The main Project activities with possible impacts on groundwater concern groundwater abstraction and the discharge of water used for hydrostatic testing.

5.7.3.2.3 Magnitude of potential impacts

The abstraction of groundwater to supply pre-commissioning and commissioning activities) has the potential to have a direct impact on the water table through drawdown, which may affect the yield of nearby boreholes and wells. The magnitude of this potential impact is ranked as **low** given the relatively short duration. The unmitigated significance is **moderate**.

Management of wastewater from hydrostatic testing of the flowlines and plant pipework may be contaminated with additives used to protect piping during the testing process. However, Pearl Petroleum will only discharge this water to ground if it meets KRI standards for such discharges. If not, this wastewater will be treated in an evaporation pond. In either case, the impact magnitude is considered to be **slight**, giving an impact significance rating of **minor**.

5.7.3.2.4 Summary

A summary of unmitigated potential impacts on groundwater during the Project pre-commissioning and commissioning phase is presented in Table 5-29.

Table 5-29 Summary of unmitigated potential impacts on water resources during pre-commissioning and commissioning

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Groundwater abstraction leading to aquifer drawdown	Low	High	Moderate	Y
Generation of wastewater from hydrostatic testing of piping leading to possible contamination of soil and groundwater	Slight	High	Minor	N

5.7.3.3 Operations phase

5.7.3.3.1 Baseline context and receptor sensitivity

Groundwater is the most important source of public water supply to the local communities and therefore the sensitivity of groundwater in the AOI is **high**.

5.7.3.3.2 Project aspects

The main Project activities with possible impacts on groundwater concern groundwater abstraction and storage and handling of hazardous substances.

5.7.3.3.3 Magnitude of potential impacts

Abstraction of groundwater leading to aquifer drawdown

The abstraction of groundwater to supply operations has the potential to have a direct impact on the water table through drawdown, which may have an indirect impact on the yield of nearby boreholes and wells. During operations, groundwater will be used to support camp offices (domestic use) and for other operational requirements. There are several existing groundwater abstraction wells and springs in the AOI and therefore the magnitude is ranked as medium. The unmitigated significance is **high**.

Reduced groundwater quality

The improper storage and handling, or loss of containment, of fuels (e.g. tanker trucks), sewage sludge, oils, lubricants and chemicals has the potential to cause potential impacts to groundwater quality. In addition, this may occur due to refuelling and maintenance of machinery, equipment and vehicles. The magnitude is **slight** given the local extent and short duration of potential impacts this could give rise to **minor** impacts.

The operation of waste accumulation areas and waste disposal sites may result in impacts on groundwater quality. The evaporation pond will be suitably lined so an assessment of potential impacts to groundwater will not be progressed any further. The improper storage of hazardous waste at these locations may lead to the mobilisation of contaminants into the subsurface and thus impact the quality of shallow groundwater.

Given a magnitude of **slight** (short duration and local extent) and a sensitivity of **high**, the impact is **minor**.

5.7.3.3.4 Summary

A summary of unmitigated potential KM250A Project operations phase impacts on groundwater is presented in Table 5-30.

Table 5-30 Summary of unmitigated potential impacts on water resources during operations

Aspect	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Groundwater abstraction leading to aquifer drawdown	Medium	High	High	Y
Storage and handling of fuels and chemicals leading to leaks/spills and reduced groundwater quality	Slight	High	Minor	N
Storage of hazardous solid and liquid waste leading to reduced groundwater quality	Slight	High	Minor	N

5.7.3.4 Decommissioning phase

During the decommissioning phase, it is expected that the operating processes will be shut down systemically in compliance with safety protocols, and the liquid and solid contents and wastes will be removed for treatment and disposal. Impacts are expected to be similar to those projected for the construction phase (see Section 5.7.3.1).

5.7.4 Noise

5.7.4.1 Construction phase

5.7.4.1.1 Baseline context and receptor sensitivity

Workers at the site are assumed to be accustomed to noise associated with construction sites. Furthermore, personal protection equipment (PPE) will be provided. However, both permanent Project workers and construction workers will be housed at camps within the Khor Mor site fenceline. Off-work workers will have the same sensitivities as residents of nearby villages. The latter are assumed to be accustomed to noise from operations of the existing Khor Mor plant. However, there are agricultural and grazing areas outside of the site fenceline as well as schools and clinics. An overall noise sensitivity level of **high** has been assigned.

5.7.4.1.2 Project aspects

The construction of the KM250A Project will generate high levels of noise. To determine whether the construction works will give rise to adverse impacts at sensitive receptors within the construction phase noise AOI (including residents of surrounding villages and workers at the site), a quantitative noise assessment has been undertaken.

The construction activities associated with the KM250A Project that have the potential to be significant in terms of noise are noted below:

- site preparation, drainage installations and general earthworks
- internal road construction
- foundations for plant/equipment
- installation of plant/equipment and prefabricated structures
- site clearance
- trenching, pipe installation and backfill.

Traffic Movements

A quantitative assessment has been undertaken to determine the potential noise impacts associated with vehicle movements associated with the construction phase of the Project.

It is anticipated that there will be heavy goods vehicles (HGVs) movement, including up to twenty two-way wagon movements during the day and twenty crew bus movements to transport local workers (about 300 in number) to and from the site.

The specific routes and frequency of HGVs has not been defined at this stage. For the purposes of this assessment a realistic worst case in which all vehicles will take the same currently low-density traffic route to and from the site has been assumed. The wagons used to transport the materials to/from the site are likely to be spaced throughout the day, rather than occurring within a concentrated period. An hourly flow of twenty HGVs has been assumed.

Noise from HGV movements have been calculated using the haul road calculation formula contained within Section F.2.5 of BS 5228-1:2009+A1:2014. The assessment has been undertaken on the basis of:

- maximum pass-by data for HGV based on a sound power level of 104 dB(A)
- peak hourly one-way flow comprising of twenty HGVs
- mean speed of 48 km/hour (30 miles per hour) when HGVs are travelling near to or through residential areas.

The resulting noise levels have been calculated at a range of typical setback distances as noted in Table 5-31. This enables the influence of HGV movements to be considered against the defined acoustic criteria.

Table 5-31 Noise from construction phase HGV movements on highway network

HGVs per hour	Noise level at a range of setback distances, dB LAeq,1hr						
	10 m	25 m	50 m	75 m	100 m	200 m	300 m
20	57	53	50	48	47	44	42

There is potential for sensitive receptors to be situated at a range of setback distances from the highway and therefore the noise levels incident at roadside properties will vary by location. Based on the values presented in Table 5-31, the road traffic noise levels will not exceed the Project Standard daytime noise limit for residential areas of 50-60 dB(A).

On the basis of the predicted levels, the noise from construction phase HGV movements has the potential to give rise to short-term, **minor** adverse impacts during daytime hours at receptors situated close to the main road.

It is recommended that the noise assessment is updated to reflect the traffic management plan once specific transport routes and vehicles numbers are confirmed.

Other sources of noise during the Project construction phase

Specific details regarding the construction activities to be undertaken will be available during the EPC phase of the Project. Therefore, the assessment of construction phase impacts is based on RSK's experience of similar works. If the final plant selections or working arrangements differ significantly to the assumptions that have been made, this assessment will need to be updated.

Estimated noise levels during the construction phase have been predicted at existing sensitive receptors in the surrounding study area using the noise propagation algorithms contained within British Standard (BS) 5228-1:2009+A1:2014. It has been assumed that construction work will be undertaken largely during daytime hours (with possible exceptions), seven days a week. For the purpose of this assessment it has been conservatively assumed that the surrounding land is flat and acoustically reflective i.e. no acoustic screening from intervening topography or ground absorption.

The anticipated plant items and associated sound pressure levels generated during the primary phases of work are presented in Table 5-32.

Table 5-32 Construction phase plant list

Activity	Plant	BS5228 Ref.	Noise at 10m, dB(A)	% on Time	No. of items in use	Total noise at 10 m, dB(A)
KM250A Project						
Site preparation, drainage & earthworks	Tracked excavator	C.2.3	78	80	3	**93**
	Roller (rolling fill)	C.2.37	79	50	2	
	Excavator mounted rock breaker	C.9.13	95	30	1	
	Grader	C.6.31	86	50	2	
	Dozer	C.2.12	81	80	3	
	Articulated dump truck	C.4.1	81	80	3	
	Lorry	C.2.34	80	30	1	
Internal road construction	Tracked excavator	C.5.35	74	80	2	**88**
	Dozer	C.5.13	82	80	2	
	Articulated dump truck	C.5.17	81	80	2	
	Vibratory roller	C.5.20	75	50	2	
	Asphalt paver + tipper lorry	C.5.31	77	80	2	

Activity	Plant	BS5228 Ref.	Noise at 10m, dB(A)	% on Time	No. of items in use	Total noise at 10 m, dB(A)
	Lorry	C.2.34	80	30	1	
Foundations for plant/ equipment	Tracked excavator	C.4.64	75	80	2	**86**
	Dump truck	C.2.30	79	50	2	
	Vibratory plate (petrol)	C.2.41	80	30	2	
	Delivery wagons - arrive/depart	C.11.7	79	20	2	
	Concrete mixer truck + pump	C.4.32	78	50	2	
	Poker vibrator	C.4.33	78	30	4	
	Vibratory tamper	C.4.35	63	30	2	
	Compressor	D.6.19	72	30	2	
Installation of plant/ equipment & prefab. structures	Wheeled mobile crane	C.4.43	70	30	2	**88**
	Telescopic handler	C.4.54	79	30	2	
	Hand-held welder	C3.31	73	30	2	
	Generator for welding	C3.32	73	30	2	
	Petrol hand-held circular saw	C.4.70	91	20	2	
	Angle grinder (grinding steel)	C.4.93	80	20	2	
	Lorry with lifting boom	C.4.53	77	30	2	
Flowlines						
Flowline - Site clearance	Tracked excavator	C.2.3	78	80	2	**87**
	Dozer	C.2.12	81	80	2	
	Dump truck	C.2.30	79	80	2	
	Dozer (towing roller)	C.2.36	81	50	1	
	Lorry	C.2.34	80	30	1	
Flowline - Trenching, pipe installation and backfill	Tracked excavator	C.4.64	75	80	2	**92**
	Excavator mounted rock breaker	C.9.13	95	30	1	
	Dumper	C.4.3	76	80	2	
	Dozer	C.2.12	81	80	2	
	Grader	C.6.31	86	50	1	
	Lorry with lifting boom	C.4.53	77	20	2	

The predicted noise levels at the surrounding sensitive receptor areas (see Table 5-9 and Figure 3-4) resulting from the primary construction activities for the KM250A Project and associated flowlines are presented in Table 5-33.

Table 5-33 Predicted construction phase noise levels at sensitive receptors

Construction activity	Noise levels at receptor areas (dB, L_{Aeq})						Project Standard (dB, L_{Aeq})		
	Khor Mor Gawra (R1)	Mamisik (R2)	Khor Mor Bichuk (R3)	Awaye Jalal (R4)	Permanent accom. Camp (R5)	Construction camp (KM250) (R6)	Residential 07:00 to 18:00	Residential 18:00 to 22:00	Residential 22:00 to 07:00
KM250A Project							50-60	45-55 See note	40-50 See note
Site preparation	46	44	49	52	64	58			
Internal road construction	41	38	44	47	58	52			
Foundations for plant/equipment	38	36	41	44	56	50			
Installation of plant & prefab structures	41	39	44	47	59	53			
Flowlines									
Site clearance	38	44	38	39	44	44			
Trenching, pipe installation and backfill	42	49	42	44	49	48			

Red - exceeds Project Standard for day time (07:00 to 18:00)
Note - in exceptional cases, construction activities will occur in the evening (18:00 to 22:00) or night-time (22:00 to 07:00)

5.7.4.1.3 Magnitude of potential impacts

Based on the predicted noise levels presented above, it is evident that the construction phase noise levels will be highest at the accommodation camps (R5 and R6), with noise levels ranging by activity, from 44 to 64 dB L_{Aeq}; the elevated noise levels are a function of the proximity to the boundary of the KM250A Project site. When considering the offsite villages (R1-R4), the highest noise levels are predicted to occur at Awaye Jalal (R4) to the south of the KM250A Project site with noise levels ranging by activity from 44 to 52 dB L_{Aeq}

In the absence of appropriate mitigation measures, the construction phase noise levels have the potential to give rise to medium-term, **minor** adverse impacts when works are undertaken during daytime hours. If the works extend into the night-time period (giving a night-time limit in residential areas of 40 to 50 dB), the unmitigated noise levels have the potential to give rise to medium-term, **major** adverse impacts.

5.7.4.1.4 Summary

Table 5-34 presents a summary of the potential construction phase noise impacts.

Table 5-34 Summary of unmitigated potential impacts on noise during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Construction activities - daytime leading to potential increases in ambient noise	Slight	High	Minor	N
Construction activities - night-time leading to potential increases in ambient noise	High	High	Major	Y
Construction traffic leading to potential increase in ambient noise	Slight	High	Minor	N

5.7.4.2 Pre-commissioning and commissioning phase

There are no specific noise impacts during the pre-commissioning stage. Noise levels during pre-commissioning are expected to be substantially lower that those occurring during the construction phase and hence will not give rise to potentially significant impacts. On this basis, pre-commissioning noise has been scoped out of the assessment.

Commissioning phase noise levels are expected to be similar to those predicted for the operations phase of the Project as defined below.

5.7.4.3 Operations phase

5.7.4.3.1 Baseline context and receptor sensitivity

See Section 5.7.4.1.

5.7.4.3.2 Project aspects

This concerns Project traffic (tanker movements), high noise-generating equipment associated with KM250A Project operations (including compressors and generators). Non-routine flaring will also generate high levels of noise.

5.7.4.3.3 Magnitude of potential impacts

Project Traffic

A quantitative assessment has been undertaken to determine the potential noise impacts associated with tanker movements associated with the operations phase of the Project. It is anticipated that the development will generate up to 50 two-way tanker movements. The assessment has considered a daytime hourly flow of ten tankers, which assumes that the tanker movements will typically be spaced throughout the day, rather than occurring within a concentrated period.

Noise from tanker movements have been calculated using the haul road calculation formula contained within BS 5228-1:2009+A1:2014. The assessment has been undertaken based on:

- maximum pass-by data for HGV based on a sound power level of 104 dB(A)
- peak hourly one-way flow comprising of ten tankers
- mean speed of 48 km/hour (30 mph) when HGVs are travelling near to or through residential areas.

The resulting noise levels have been calculated at a range of typical setback distances as noted in Table 5-35. This enables the influence of offsite tanker movements to be considered against the defined acoustic criteria.

Table 5-35 Noise from operations phase HGV movements on highway network

HGVs per hour	Noise level at a range of setback distances, dB LAeq						
	10 m	25 m	50 m	75 m	100 m	200 m	300 m
10	54	50	47	45	44	42	41

There is potential for sensitive receptors to be situated at a range of setback distances from the highway and therefore the noise levels incident at roadside properties will vary by location. On the basis of the values presented in Table 5-35, the road traffic noise levels will not exceed the Project Standard daytime noise limit for residential areas situated adjacent to main roads of 50-60 dB(A).

On the basis of the predicted levels, the noise from operations phase tanker movements have the potential to give rise to short-term, **minor** adverse impacts during daytime hours at receptors situated close to the main road. The noise assessment should be updated to reflect the Traffic Management Plan once specific transport routes and vehicles numbers are confirmed.

Site operations

The noise levels generated by the operation of the KM250A Project have been calculated using the computational noise modelling software SoundPlan (v8.1). The software calculates industrial noise from mobile and static sources in accordance with International Standard ISO 9613-2:1996 '*Acoustics, attenuation of sound during propagation outdoors. General method of calculation*'.

The ISO 9613-2 method predicts noise levels under meteorological conditions favourable to noise propagation from the sound source to the receiver, such as downwind propagation. The modelling parameters are presented in Table 5-36 and are considered to provide realistic worst-case predictions. The methodology takes account of the following physical effects:

- geometrical divergence
- atmospheric absorption
- ground effect

- reflection from surfaces
- screening by obstacles.

At this stage in the assessment, vendor datasheets are not available for the proposed plant installations. In the absence of vendor/measurement data, the noise emissions from the proposed plant items will generally not exceed a level of 85 dB(A) at 1 m as defined in the KM250A Project 'Basis of Design, rev B' (Hatch 2019c). The main exceptions are the temporary generators which has been modelled as 97 dB(A) at 1 m and the maintenance flaring which has been modelled with an assumed sound power level of 115 dB(A).

Peak noise associated with non-routine flaring events are assumed to result in a sound power level of 126 dB(A) at each of the two flares. The predicted noise levels during non-routine flaring events are only expected to occur for a 15-minute duration, no more than twice a year.

Table 5-36 Operational phase modelling parameters

Parameter	Setting
Algorithm	International Standard ISO 9613-2:1996 *'Acoustics, attenuation of sound during propagation outdoors. 'General method of calculation'*
Ground Absorption	Mixed ground (0.4 coefficient) – hardstanding areas and sand
Met Conditions	25 ^{o}C 60% humidity Wind from source to receiver
Façade Corrections	Not applied i.e. results represent free-field noise levels
Receptor Height	A receptor height of 1.5 m above ground level has been assumed
Modelling Scenarios	**Routine scenario** - Noise contribution from the primary components of KM250A Project under routine operating conditions. **Non-routine scenario** - Noise contribution from the primary components of KM250A Project, in addition to non-routine flaring events.
Source Modelling/ Data	The prominent noise producing items of plant associated with the KM250A Project have been established from the Hatch Master Equipment List (Hatch, 2019m). The equipment list was annotated by the Hatch engineering team to identify significant plant items in terms of noise generation. All calculations have been performed in the eight octave bands centred between 63 hertz (Hz) and 8 kilohertz (kHz). Note: in the absence of spectral noise data, this information will be derived from similar plant installations taken from RSK's database. It is assumed that the proposed plant installations will operate continuously during both daytime and night-time periods.

Parameter	Setting
	No allowance has been made for directivity of the plant noise emissions i.e. model assumes omni-directional propagation. With the exception of the flares, all plant items have been modelled with a source height of 2 m above local ground level. The LP and HP flares have been modelled with a source height of 20 m and 50 m above local ground level respectively (assumed to flare concurrently).
Assessment Period	1-hour assessment period for both daytime and night-time assessment periods
Terrain	The noise prediction model has incorporated 10 m elevational contours beyond the KM250A Project site.
Barriers/structures	The model does not incorporate features on site which may provide partial screening (e.g. columns, pipe racks, structural steelwork, and small equipment). Consequently, the contribution of certain sources, particularly those located well within the facility, may be overestimated. No allowance has been made for barriers or large obstructions, therefore the results represent robust predictions. Note: a substantial structure (building) or barrier can provide a sound reduction of 5-15 dB(A) if it obscures the source from view at the receiver position.
Site Layout	The KM250A Project plot plan has been taken from Hatch drawing ref. *'H358098-00000-250-290-0002 Rev. 1'*

The predicted KM250A Project operations phase noise levels at the surrounding sensitive receptor areas are presented in Figure 5-12, Figure 5-13 and Table 5-37; for context, the existing baseline noise environment has also been presented. The predicted values do not include existing noise sources associated with the wider facility on the basis that these form part of the current noise environment captured during the baseline survey.

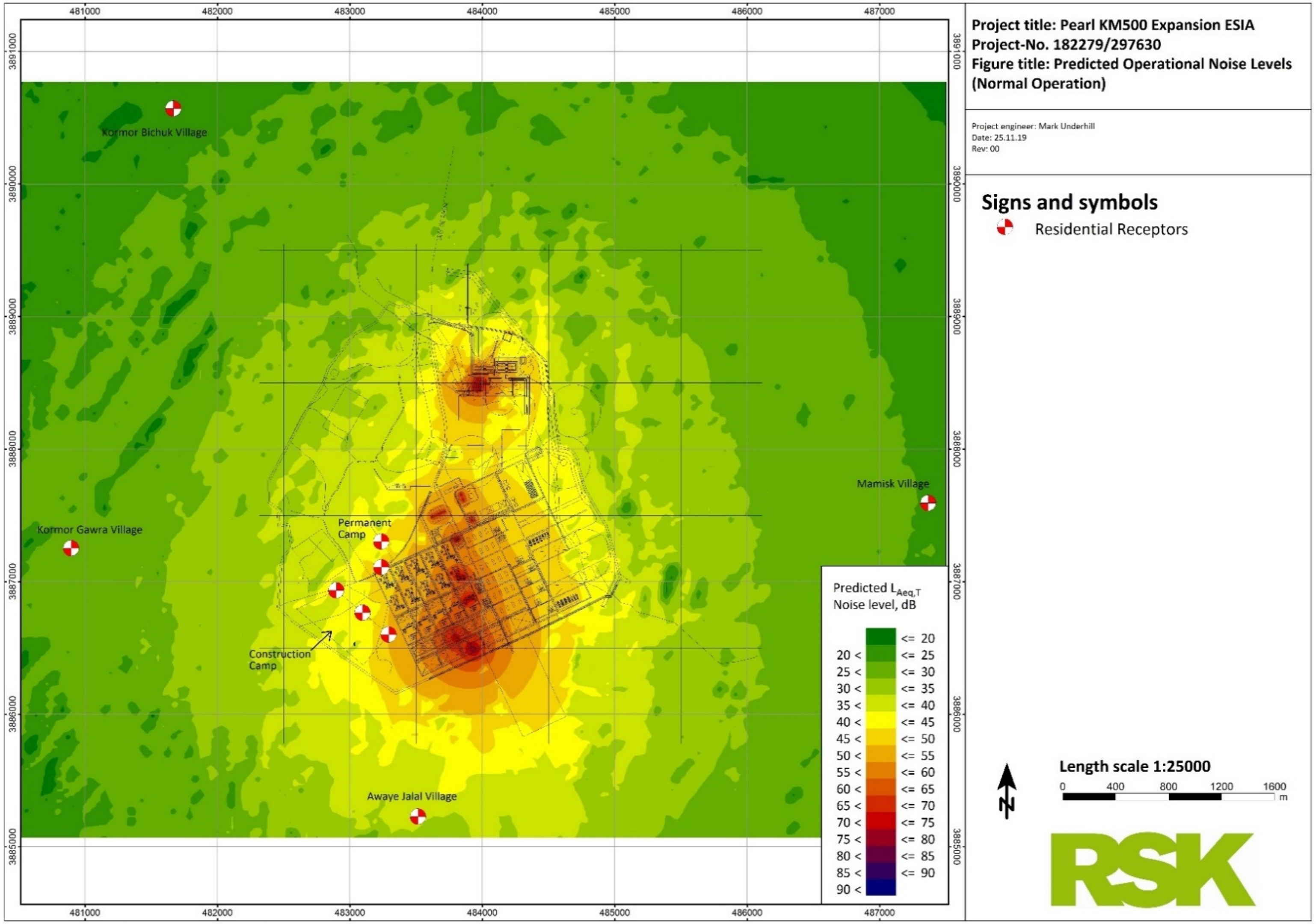

Figure 5-12 Predicted operations phase noise levels under routine conditions (1.5 m above ground level)

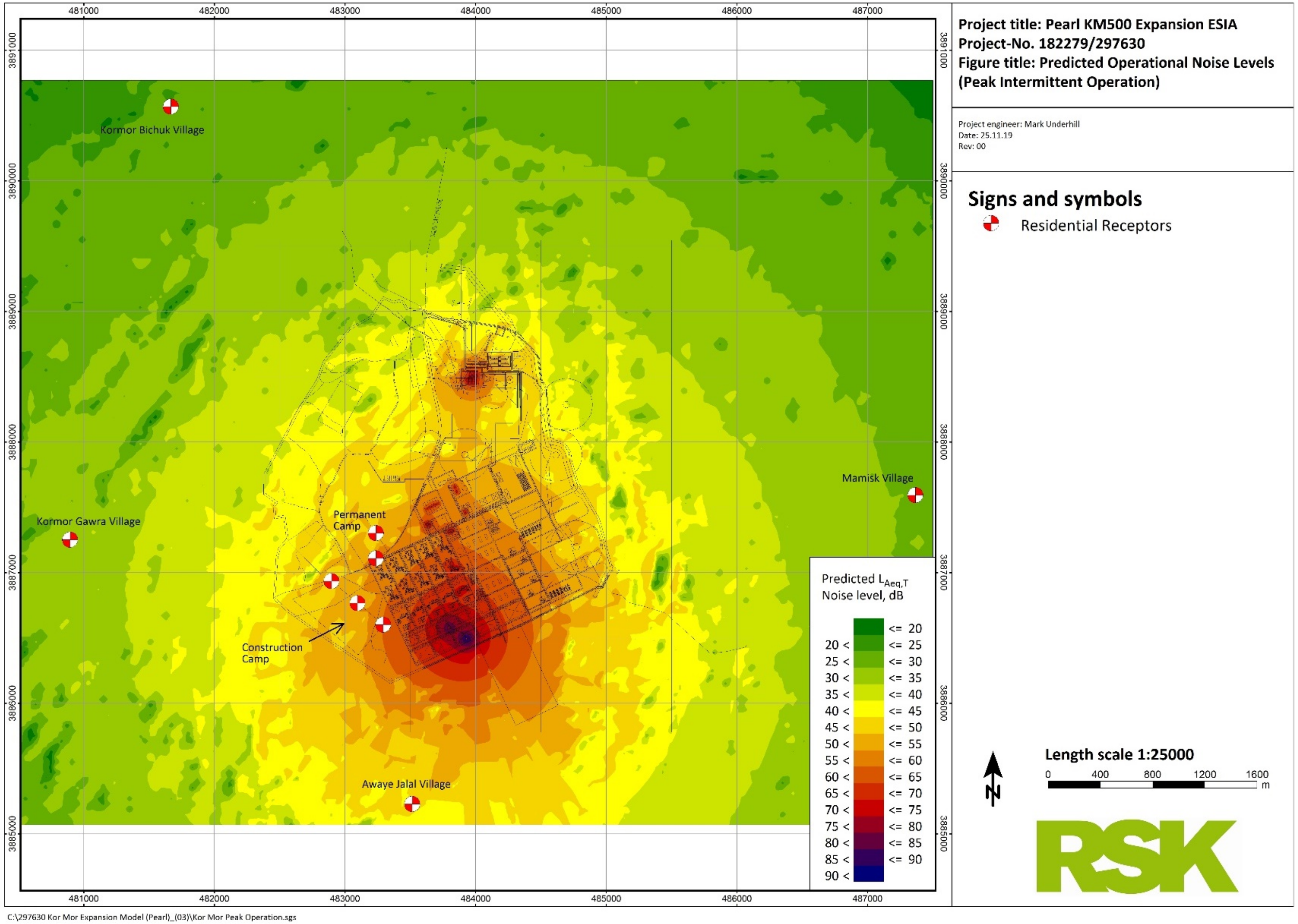

Figure 5-13 Predicted operations phase noise levels under non-routine conditions (1.5 m above ground level)

Table 5-37 Baseline and predicted operations phase noise levels

Condition	Noise levels at receptor areas, (dB)						Residential Project Standard
	Khor Mor Gawra	Mamisik	Khor Mor Bichuk	Awaye Jalal	Permanent accommodation camp	Construction camp (KM250)	
Baseline – Daytime ambient, $L_{Aeq,15hr}$	41	36	43	47	52	-	50-60
Baseline – Night ambient, $L_{Aeq,9hr}$	50	40	41	43	51	-	40-50
Baseline – Daytime background, $L_{A90,15hr}$	33	27	33	36	40	-	50-60
Baseline – Night background, $L_{A90,9hr}$	35	27	34	38	47	-	40-50
Predicted KM250A Project noise levels, $L_{Aeq,1hr}$ – **Routine** operating conditions	27	25	23	39	48	50	As above (depending on night-time or daytime)
Predicted KM250A Project noise levels, $L_{Aeq,1hr}$ – **Non-routine** operating conditions	33	30	27	49	56	60	As above (depending on night-time or daytime)

Red – exceeds Project Standard

Under routine operating conditions, it is evident that the operations phase noise levels will be highest at the adjacent Project camp locations with predicted noise levels up to 50 dB $L_{Aeq,1hr}$. When considering the offsite villages, the highest noise levels under routine operating conditions are predicted to occur at Awaye Jalal to the south of the site with predicted noise levels of 39 dB $L_{Aeq,1hr}$.

For the Project camp areas, the absolute noise levels during routine operating conditions should not adversely affect the functionality of the camp areas during daytime or night-time periods, particularly when considering the noise attenuation provided by boundary treatments e.g. walls, the external envelope of the accommodation blocks and the screening provided by the buildings themselves.

During non-routine flaring, a substantial increase in noise, most notably at the Project accommodation camp locations and Awaye Jalal, has been predicted. As noted above, the non-routine flaring events are only expected to occur for a 15-minute duration, no more than twice a year. On this basis, the elevated noise resulting from these infrequent and short duration non-routine events are not considered to give rise to significant adverse noise impacts.

On the basis of routine operating conditions, the predicted noise levels have the potential to give rise to long-term, **minor** adverse impacts during both daytime and night-time periods at the surrounding villages. During non-routine operating conditions, the predicted noise levels have the potential to give rise to long-term, **minor** adverse impacts at the surrounding villages. The impact significance for the non-routine operating condition reflects the limited timescales over which flaring will occur throughout the year.

5.7.4.3.4 Summary

Table 5-38 presents a summary of potential impacts on noise during the operations phase of the KM250A Project.

Table 5-38 Summary of unmitigated potential impacts on noise during operations

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Potential noise impacts due to **routine** KM250A Project operating conditions - daytime	Slight	High	Minor	N
Potential noise impacts due to **routine** KM250A Project operating conditions – night-time	Slight	High	Minor	N
Potential noise impacts due to **non-routine** KM250A Project operating conditions	Slight	High	Minor	N

5.7.4.4 Decommissioning phase

5.7.4.4.1 Baseline context and receptor sensitivity

See Section 5.7.4.1.

5.7.4.4.2 Project aspects

Decommissioning phase activities expected to generate noise are associated with:

- noise from machinery and dismantling activities
- site clearing, grading and levelling.

5.7.4.4.3 Magnitude of potential impacts

The noise associated with the decommissioning process will be limited in duration and extent, with predicted noise levels that are similar to those identified during the construction phase. At this stage, it is assumed that the decommissioning works will be undertaken during daytime hours only. On this basis, there is potential for the decommissioning activities to give rise to noise impacts of **minor** significance (see Table 5-39).

5.7.4.4.4 Summary

Table 5-39 presents a summary of the potential decommissioning phase noise impacts.

Table 5-39 Summary of unmitigated potential impacts on noise during decommissioning

Aspect	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Potential increases in ambient noise due to daytime decommissioning activities	Slight	High	Minor	N

5.7.5 Biological environment

5.7.5.1 Construction phase

5.7.5.1.1 Baseline context and receptor sensitivity

Parts of the KM250A Project footprint and the surrounding environs comprise natural habitat and may be inhabited by vulnerable or threatened species. The flowlines will be developed in some areas of natural habitat, although at certain points the flowlines will be within the same right of way (RoW) of existing flowlines. The impact assessment has been undertaken based on ecological and biodiversity baseline characteristics of the construction phase biodiversity/ecology AOI, which includes the area within and surrounding the Project fenceline (see Section 3.3.1) and within the new flowline RoWs.

Receptor sensitivity varies. Habitat and biodiversity within the Khor Mor site fenceline are considered of relatively low importance and presence. Furthermore, the site contains an existing industrial facility and is likely to tolerate some disturbance. These habitat and species have been assigned a sensitivity of **medium**. Sensitivity of vulnerable plant species is considered **high** (one herbaceous plant species, *Thymus neurophyllus*, triggers critical habitat being of restricted range - see Section 5.7.5.5).

5.7.5.1.2 Project aspects

The following construction phase activities have the potential to cause direct or indirect impacts on ecology and/or biodiversity within the AOI:

- habitat clearance and landscaping within the Project area may result in direct permanent loss of natural and modified habitats
- site clearance for temporary units such as camps, office buildings, utility areas and storage areas may result in direct temporary habitat loss and poor re-colonisation of flora following reinstatement due to soil erosion or compaction
- site clearance and vehicle movements may result in direct mortality of fauna species
- the accidental transfer and spread of alien invasive plant species during construction and earth moving activities may impact habitats and native flora
- noise and visual disturbance may cause indirect impacts on fauna species at the site and in surrounding area

- construction workers based on the site may cause indirect impacts on species and habitats through inappropriate disposal of waste and wastewater and human disturbance
- oil or chemical spills from construction activities may directly impact surrounding flora and fauna and cause injury or mortality through contamination of food and water sources.

5.7.5.1.3 Magnitude of potential impacts

Habitats and flora

Site clearance, stripping of topsoil, site preparation, excavation and grading works undertaken within the Project has the potential to result in direct permanent loss of natural Mesopotamian shrub desert habitat (steppe grassland) and modified habitats (agricultural land). These natural habitats are not of conservation importance at the national or global scales. The ongoing stakeholder consultation will provide information on any grazing that may take place in the AOI associated with the flowlines.

The clearance works will result in the loss of native common vascular plant species and may potentially result in the loss of individual plants that are endemic, rare or threatened at the national or global scales. No nationally rare flora species where observed during the field surveys; but the surveys provided just a snapshot in time rather than a full species assemblage. Flora species found within the Chemchemal KBA with potential to occur in the Project area are Xi Zang Xiao Mai (*Triticum aestivum*; IUCN 2019 listed Data Deficient) and *Triticum durum* (not assessed by IUCN 2019). These species are cultivars specific to the region and therefore of significance as genetic resources. Species of national or international conservation importance identified from the critical habit assessment such as *Thymus neurophyllus* (herbaceous plant) that has a restricted range may be present in the Project area but were not observed during field surveys.

Terrestrial habitats within the vicinity of the Project footprint are at risk of being damaged by Project activities during construction. It is therefore anticipated that site preparation works and associated facilities will result in the degradation or loss of terrestrial habitats from land adjoining the Project footprint (for example through the transport of vehicles, stockpile sites, vehicle access routes, equipment storage facilities etc.) but within the Khor Mor site fenceline. The construction phase will result in temporary and permanent habitat loss as detailed in Table 5-40. The habitats do not support flora species of conservation importance at the global scale and as such the habitats within the Project footprint are considered to be of moderate sensitivity.

Although there is aquatic habitat within the AOI (one pond and some ephemeral reedbeds) they will not be directly affected by the development. Potential indirect impacts include sedimentation and pollution caused by the construction phase activities such as ground clearance and vehicle fuelling.

Table 5-40 Estimation of habitat loss through site clearance activities

Category	Area (km^2)	Type of loss
Steppe Grassland	1.592	Permanent
Cultivated Land	3.244	Permanent
Steppe Grassland	1.004	Temporary

The increased movement of people into a region can have detrimental effects on natural habitat as workers and families increase their utilisation of natural resources for example wood for fuel, collection of medicinal plants, hunting of wild animals and fishing. The extent of in-migration due to the Project is expected to be small as the workforce are likely to be local and therefore impacts are considered to be of a **low** magnitude. The workforce will be housed in a construction camp within the existing fenceline or will be employed from the local area, and so are unlikely to have detrimental effects on natural habitat outside of construction works. Local workers living at their homes will be bused offsite to their respective villages at the end of every working day. Workers based at construction camps within the fenceline will not be allowed to go beyond the fenceline, and will be instructed regarding risks to sensitive habitat or species.

There is also risk of habitat loss and degradation through accidental spills or seepages of hazardous substances (i.e. diesel fuel, oil, concrete etc) and grey-water or septic systems. This impact would most likely occur within the construction site fenceline and near the construction camp where sewage will be generated.

Project-related movement of people and vehicles arising from construction activities increases the risk of the introduction and transfer of invasive alien species of vascular plants into the Project area. Alien invasive species are often aggressive competitors, rapidly outcompeting existing plant species thus degrading the floristic diversity of habitats and dominating areas. The use of herbicides, burning, mowing and clearing generally favours disturbance-tolerant invasive plants which can rapidly colonise human-disturbed areas. Likely colonisation sites will be on the edges of new and old access routes and tracks and cleared areas (ISSG, 2018). Whilst the presence of alien invasive vascular plants within the AOI is currently unknown, seeds or rhizomes of invasive species (e.g. Water Hyacinth (*Eichhornia* Spp.) which is problematic in the region (Ministry of Environment, 2010)) could potentially be transferred from affected areas into the Project area by vectors e.g. workers and Project vehicles. No invasive alien species were observed during the field surveys.

Fugitive dust emissions measured as particulate matter of varying particle size (e.g. PM_{10} and $PM_{2.5}$) will be generated by land clearance and earthwork activities (see also Section 5.7.1.1). Construction of the plant, pipeline and access routes will expose the area to wind erosion, resulting in dust generation. Dust emissions generated by the habitat clearance and landscaping are likely to be wider-reaching depending on weather conditions.

An accumulation of dust on leaves can block stomata and thereby impact on normal photosynthetic, transpiration and cellular respiration rates (Sharifi et al., 1997) and finer dust can be directly taken into the stomatal openings (Farmer, 1993) impairing the biological fitness of plants. Prolonged smothering can result in the mortality of the plants. Habitats and flora located near the dust emission sources are expected to experience the greatest impacts during construction. Assessment of impacts from dust and gaseous emissions were identified as of **minor** significance and hence impacts on flora are also considered **minor**.

Vehicles and plant machinery that use diesel fuel will generate combustion emissions such as CO, SO_2, NO_x, particulate matter (PM_{10} and $PM_{2.5}$) and VOCs. Respiration of nitrogen and sulphur oxides can potentially have a significant impact on the biological fitness of vascular plants (Emberson et al., 2001). However, the magnitude of air quality impacts from the combustion of diesel fuel during construction is expected to be relatively **low**. Consequently, impacts on flora is also expected to be **low**.

The Project will mainly result in the loss of areas of previously cultivated land and modified habitats within the KM site fenceline with some small patches of natural habitat affected, leading to an impacts severity of **moderate**. The un-mitigated significance is rated as **moderate**.

As the flowlines will be buried and the land restored, flowline impact will be **moderate**.

Restoration of habitat (particularly over the buried flowlines) can be negatively affected by soil erosion and/or compacted soils if not managed adequately during the construction phase. This impact has been given a significance rating of **moderate**.

The gas plant footprint is not considered to be an important habitat for vulnerable species. Significance of this impact has been rated as **moderate**.

Fauna, avifauna and their habitats

It is expected that vegetation clearance works undertaken within the KM250A Project site and associated flowlines has the potential to result in permanent and temporary loss of fauna habitat. Fauna habitat loss is expected to initially result in the displacement of some fauna species from within these areas. It is anticipated that due to the current level of disturbance in the AOI and low fauna habitat availability, fauna habitat loss is likely to result in the displacement of a few individuals of fauna such as birds, reptiles and small mammals (short tailed bandicoot rat and Indian mongoose for example). The existing level of habitat connectivity within the AOI is high enough that resources and habitat availability will allow the movement of fauna during all Project phases. Furthermore, the existing Khor Mor site fenceline already forms a barrier to movement for some species. The KM250A Project will not change this, and local fauna are assumed to have adapted.

Fugitive dust emissions (e.g. PM_{10} and $PM_{2.5}$) and combustion emissions air pollutants (i.e. SO_2, CO, NO_x, particulate matter and VOCs) will be generated during the construction phase which will be localised and staged over a short construction period. Significant dust emissions are expected to result from the use habitat clearance grubbing and grading works prior to mitigation. Dust emissions are likely to be wider reaching in windy conditions. The magnitude of impacts to fauna arising from the inhalation of these dust emissions and air pollutants is dependent on the quantity, composition, respiratory rates and health of fauna. Emissions can cause irritation and impairment of respiratory functions, skin irritation and vision impairment of fauna. Potential impacts may be cumulative in nature. Pollutants could also be ingested (for example when deposited on plants or fruit which is then consumed) and then adversely affect the health of fauna.

The predominant noise emissions generated during the pre-construction and construction phase will be generated by sources such as vehicle traffic, plant vehicles, and machinery (i.e. pile drivers, excavators/grader and vibratory rollers). Construction noise emissions will be generated over a two-year period. It is anticipated that ground vibration generated during construction by vehicle traffic, plant vehicles, and machinery will be comparatively more localised. Unfamiliar and/or loud noise and vibration emissions are known to evoke a flight reaction in fauna.

Mammals and birds are also known to experience stress, reduced biological fitness and decreased breeding success on exposure to noise (Francis and Barber, 2013). Chronic stress can increase species' susceptibility to diseases, pathogens and parasites (Dhabhar, 2002; Sapolsky et al., 2000). High noise and vibration levels may also compromise hearing by damaging inner-ear structures, provided that the acoustic energy is within an animal's sensory range and the animal is close to the source (Barber et al., 2010). The social behaviour of birds and mammals could be adversely affected if vocalisations are masked or the perception of sound is inhibited by high noise and vibration levels, as a large proportion of these species rely on acoustic signals for courtship and mating and predator detection and avoidance.

However, some birds and mammals are known to develop short-term adaptations to noise, such as vocal adjustments (i.e. changing song frequencies, amplitude or timing; Barber et al., 2010). Species that are quickly able to adapt to changes in ambient noise and vibration levels are less affected than species that are unable to adapt. If noise or vibration is perceived as a threat, animals can increase vigilance and anti-predator behaviour (Francis and Barber, 2013). It is anticipated that noise and vibration emissions arising from habitat clearance and construction activities will result in the displacement of fauna from habitats within the AOI . Species such as raptors and graminivorous birds are likely to be temporarily displaced from the site during construction but suitable habitat is present in the wider area, so this displacement is unlikely to affect species survival.

Light spill is known to cause disturbance to crepuscular (fauna that are active primarily during dawn and dusk) and nocturnal species and can cause a range of behavioural changes such as altered feeding and roosting patterns. Light spill may affect the circadian rhythms and cycles of activity of nocturnal, crepuscular and diurnal species, including disruption of seasonal acclimatisation, disruption of predator-prey relationships, increased prey intake and altered reproduction behaviour (Gaston et al., 2013; Longcore and Rich, 2004). Many species use lightscapes (e.g. moonlight) as cues for movement around their environment and altering these lightscapes by light pollution may disrupt these movements by disorienting the animal (Gaston *et al*., 2013). This can potentially result in physiological stress and thereby reduced biological fitness. It is expected that artificial lighting may result in the localised displacement of crepuscular and nocturnal species such as foraging bats and small mammals like the Indian mongoose from within the Project area.

Construction activities (i.e. habitat clearance, earth works, excavating and levelling works etc) present a risk of accidental fauna collisions with vehicles and machinery resulting in injury or mortality to some individuals. Fauna will be most at risk in the construction footprint and access tracks where the majority of vehicle movement and machinery activity will occur, and fauna will be particularly vulnerable during habitat clearance works. Whilst the likelihood of death or injury may be partly reduced as medium sized fauna and avifauna are expected to avoid areas of high construction activity due to disturbance (i.e. noise, vibration, artificial lighting and presence of humans etc), small-ranging species, slow moving species and small sized mammals which are less able to quickly move away from operating machinery and vehicles and are expected to be killed or injured during the construction phase prior to mitigation.

Construction activities may result in introduction of invasive species to the site (for example via the import of gravel and other raw materials), but the likelihood is **low**. The significance of this possible impact has been rated **slight**. Fauna currently inhabiting areas in and around the Project footprint are accustomed to noise from the existing gas plant and related activities, although construction activities may have more direct impacts on habitat. A significance of **moderate** has been given to possible noise impacts.

Although the existence of bird nesting activities can change with time it is likely that some ground nesting birds will be present in and around the Project footprint, the possible impact of Project construction activities on such activities is considered **moderate**. No bird species of conservation importance were observed during the baseline surveys but species such as steppe eagle (IUCN EN) and sociable lapwing (IUCN CR) have the potential to be present from known distributions. .

Direct mortality of species from collisions with equipment and vehicles and through site clearance works may occur and has been given a **moderate** significance rating, although species likely to be affected are not considered to be of conservation importance. Injury/mortality of fauna and flora from illegal hunting and collection of natural resources by workers is considered to have a low probability given that influx (in-migration) is not expected to be significant as employees will be from the local region and most construction workers will be living in a designated construction camp on the site, and so has been given an impact rating of **minor**. Permanent loss and fragmentation of breeding and foraging habitat (fauna) will result in a significance rating of **moderate**.

The possible impact of habitat loss and injury/mortality of flora and fauna from food and surface water contamination from chemical spills and sedimentation due to the Project is related to the impact of contamination of soil and sources of water during the construction phase (see Sections 5.7.2.1 and 5.7.3.1). This impact has been rated **moderate**.

5.7.5.1.4 Summary

Construction phase Project impacts are summarised in Table 5-41.

Table 5-41 Summary of unmitigated potential impacts on ecology and biological environment during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Development of Project footprint leading to potential direct permanent loss of ecologically significant habitat and vegetation	Medium	Medium	Moderate	Y
Development of Project footprint (for areas to be restored after construction such as storage areas, construction camp, flowlines) leading to potential direct temporary loss of ecologically significant terrestrial habitat and vegetation within flowline RoW and other temporary facilities.	Low	High	Moderate	Y
Various construction activities leading to permanent loss and fragmentation of breeding and foraging habitat (fauna)	Low	High	Moderate	Y
Site preparation leading to soil erosion or compaction resulting in poor re-establishment of vegetation	Medium	Medium	Moderate	Y
Transport of materials to the site leading to introduction of alien invasive species out-competing native species	Slight	Medium	Slight	N
Various construction activities leading to noise and disturbance to fauna	Medium	Medium	Moderate	Y
Various construction activities leading to disturbance, loss of prey availability and potential accidental mortality to foraging and nesting birds	Medium	Medium	Moderate	Y
Illegal hunting and collection of natural resources by Project workers leading to injury/mortality of fauna and flora	Slight	High	Minor	N
Site clearance works leading to direct mortality of species from collisions with equipment and vehicles	Low	High	Moderate	Y
Inadvertent chemical spills leading to habitat loss and injury/mortality of flora and fauna from food and surface water contamination	Medium	Medium	Moderate	Y

5.7.5.2 Pre-commissioning and commissioning phase

This phase will involve hydrotesting of piping at the site and the flowlines, testing of equipment and plant start-up. Very little impact on the biological environment would be expected during this phase, with the possible exception of flowline hydrotesting. Construction activities will have essentially ended, and traffic to and from the site will have significantly diminished. The unmitigated potential impacts during the pre-commissioning and commissioning phase of the Project are expected to be similar to the operations phase impacts below.

5.7.5.3 Operations phase

5.7.5.3.1 Baseline context and receptor sensitivity

See Section 5.7.5.1.

5.7.5.3.2 Project aspects

The following operations phase activities have the potential to cause direct or indirect impacts on the environment if not mitigated, above and beyond the impacts of existing site activities:

- barriers and fencelines around the Project facilities causing restrictions to the movement of fauna
- operational activities such as movement of people and vehicles and gas flaring have the potential to cause noise and visual disturbance,
- air quality issues resulting in potential increase of NOx and other emissions affecting flora communities
- the operation may cause light pollution that may affect nocturnal species
- the disposal of impacted wastewater from operations may affect the quality of groundwater causing amphibian, mammal and bird mortality or reduced vitality
- unplanned spills or events may cause release of oil to the environment causing direct impacts on habitats and flora and fauna species through impacts to water sources and terrestrial habitats.

5.7.5.3.3 Magnitude of potential impacts

Habitats and flora

Fugitive dust emisions and combustion emissions air pollutants (i.e. SO_2, CO, NO_x, particulate matter and VOCs) will be generated during the operations phase through the movement of vehicles and through some operational processes. Dust emissions are likely to be much lower than during the construction phase as roads will be paved.

Project induced in-migration typically causes increased pressure on natural resources in an area as more people use resources such as wood for fuel. However, in this area wood is not a common heating or cooking fuel and therefore impacts are likely to be of **slight** magnitude.

Emissions have the potential to affect the biological fitness of vascular plants (Emberson *et al*., 2001) but the magnitude of this potential impact is considered **low**.

Unplanned events such as spills of hydrocarbons from vehicles and other operational events are unlikely but present a risk to habitats and flora. Stomata of plants can become smothered and lethal effects can occur from contaminants causing death of plants and vegetation communities. Effects are less likely on larger woody species and trees.

Although air emissions from the Project will increase overall site air emissions, the significance of the possible impact on habitat and flora is considered **minor**.

Fauna

Barriers and fences around the operational site have the potential to cause restriction of movement of fauna and fragmentation of habitats. Many species in the area are wide ranging and highly mobile (e.g. wild cat) and can easily navigate around barriers without major disruption. However, small species including small mammals and reptiles may be affected by long-term range restrictions. As the existing facility is already fenced, habitat fragmentation from additional fencing is not considered to be a significant impact.

The operation of the plant will produce noise and visual disturbance from movement of people and vehicles and maintenance activities. These activities can result in stress, reduced biological fitness and decreased breeding success in mammals and birds (Francis and Barber, 2013). Sudden noise can cause a flight response especially to infrequent noises. It is anticipated that noise and vibration emissions arising from operational activities will result in the displacement of fauna from habitats within the Project footprint and surrounding environs.

Light spill is known to cause disturbance to crepuscular (fauna that are active primarily during dawn and dusk) and nocturnal species (i.e. bats) and can cause a range of behavioural changes such as altered feeding and roosting patterns. Light spill from the operational facility is likely to cause displacement of fauna from habitats within the Project footprint and surrounding habitats.

The fenceline will keep fauna away from the Project's operating facilities, thus limiting exposure to site activities. Significance is therefore rated as **slight**. Similarly, noise and vibrations are likely to have **minor** impacts on mammals and birds (existing activities within the fenceline are likely to cause birds to avoid the site). Hunting is likely to be minimal for the same reasons cited in the construction phase impact section (see Section 5.7.5.1), and so is rated at **minor** significance.

5.7.5.3.4 Summary

Table 5-42 presents a summary of unmitigated potential Project impacts on ecology and biology during the operations phase.

Table 5-42 Summary of unmitigated potential impacts on ecology and biological environment during operations

Aspect	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Barriers and fencelines restricting movement of fauna	Slight	Low	Slight	N
Air quality issues resulting in a potential increase of air emissions affecting flora communities	Low	Medium	Minor	N
Noise and visual disturbance affecting birds and mammals	Low	Medium	Minor	N
Contamination of fauna food and water supply from human waste	Low	Medium	Minor	N
Lighting from the operation affecting nocturnal species	Low	Medium	Minor	N
Illegal human activities such as hunting and collecting natural resources	Slight	High	Minor	N
Disturbance from noise and vibration from people using the office area	Medium	Medium	Moderate	Y
Injury/mortality of flora and fauna from food and surface water contamination from chemical spills and sedimentation	Medium	Medium	Moderate	Y

5.7.5.4 Decommissioning phase

During the decommissioning, demolition and removal of all facilities on completion of operation, the activities that could potentially have a significant impact on ecology and biological environment include site clearance and ground restoration activities that would result in the limited removal of flora and associated fauna occurring within the Project site area. The potential impacts during this phase on habitats, flora and fauna are considered of negligible significance as there are not expected to be habitat and species of conservation importance at this phase. Indirect effects on species outside of the construction footprint from noise and disturbance are the same as discussed for the construction phase.

5.7.5.5 Impacts on critical habitat qualifying species

The following species (present in the region) are considered to trigger critical habitat:

- Euphrates softshell turtle (reptile)
- steppe eagle (bird)
- *Thymus neurophyllus* (herbaceous plant)
- yellowfin barbel (fish)
- Siebenrock's Caspian turtle (reptile).

A detailed assessment of potential impacts on critical habitat qualifying species is provided in the Critical Habitat Assessment (RSK, 2020) and a summary provided below.

Impacts on all of the critical habitat qualifying species were considered to be insignificant (minor or slight) and no biodiversity offsetting/net gain is required.

The Euphrates softshell turtle and the Siebenrock's Caspian turtle utilise lakes and ponds. There is one pond within the existing facility fenceline (but not within the KM250A Project area) which will not be directly affected by the habitat clearance required for development. Potential impacts include sedimentation and pollution caused by the construction phase and accidental spills of fuel during an unplanned event in the operations phase. Impacts on the Euphrates softshell turtle and Siebenrock's Caspian turtle (if present) will be **minor**.

The steppe eagle is a species with a large home range who may either winter or pass through the KM250A Project AOI on migration. Potential impacts include disturbance during construction operations which may result in a temporary avoidance of the area. Measures set out in Section 6.5 will minimise impacts from disturbance. As these raptors use large expanses of land and the proportion of habitat affected is small compared to overall availability, impacts on these species are considered to be **minor**.

Thymus neurphyllus is a poorly understood herbaceous plant species endemic to the region. It is likely to be associated with natural habitats on steeper rocky substrates. Potential impacts include direct loss through habitat removal and poor reinstatement following temporary habitat loss however residual impacts are considered to be **minor**.

The yellowfin barbel and binni are freshwater fish that inhabit large rivers, lakes and reservoirs. These habitats do not occur within the 1 km and 2 km AOI and no impacts are expected on any of these habitat types outside of the AOI through construction activities. As such impacts on this species is expected to be **slight**.

5.7.6 Waste management

This section concerns the possible impacts on existing capacity in the general Project area for managing wastes that will be generated by the KM250A Project. The impacts of inadequate waste management (on air quality, soil and water resources) are addressed in those sections (respectively Sections 5.7.1, 5.7.2 and 5.7.3).

5.7.6.1 Construction phase

5.7.6.1.1 Baseline context and receptor sensitivity

Pearl Petroleum has experience with waste management in the general Project area based on the operating Khor Mor gas plant and other Pearl Petroleum facilities in Kurdistan. There is some capacity for management of sanitary (municipal type) waste in the KRI. There is limited recycling of hazardous and non-hazardous waste, but in general KRI capacity for managing hazardous waste (including final disposal) is very limited, however, these will be stored at on-site facilities that will meet international standards. Overall sensitivity of the receptor (offsite waste management facilities that will receive Project waste) is rated **medium**. Similarly, residents along the transport route for waste chemicals and waste oils that are transported to offsite management facilities are considered to have **medium** sensitivity.

5.7.6.1.2 Project aspects

During the construction phase, waste is expected to be generated on-site from several activities, including:

- site preparation (earthworks, site grading, etc.)
- facilities installation
- flowline laying activities
- infrastructure construction
- maintenance of vehicles and equipment
- excavation works
- management of construction waste
- management of chemicals, fuel and other materials.

5.7.6.1.3 Magnitude of potential impacts

Inadequate waste disposal has the potential to result in contamination of the physical environment and subsequent public health issues. Waste generated during the construction phase of the Project will be collected in suitable containers that have proper signage and labels. It will be stored on-site in areas designated with paving and bunds to prevent leachate and the spreading of liquids, and windbreaks and fencing to prevent foraging by vermin and the consequent increase of birds and mammals of prey. Without mitigation, a **minor** impact is anticipated.

Poor waste handling, storing or disposal resulting in leaks from storage receptacles or spills for either hazardous wastes have the potential to cause negative impacts on soil and groundwater during construction activities, as described, respectively, in Sections 5.7.2.1 and 5.7.3.1.

Hazardous wastes will be appropriately segregated, waste containers will be maintained in good condition, properly labelled, kept closed and safely stored. However, there are no third-party hazardous waste disposal facilities in the region, other than some recycling facilities for non-hazardous waste, waste chemicals, waste oil and used batteries. There is some risk to spillage of liquid hazardous wastes. Packaging, transport vehicles and transfer of care, custody and control will be designed in line with international (UN) standards. Drivers will be trained regarding safe conduct and response to emergencies *enroute*. Therefore, the magnitude of this impact is considered to be **low**, This gives an impact significance of **minor**.

Exceeding the capacity of regional non-hazardous regional waste management facilities is considered unlikely and will not be considered here. Although construction wastes may be higher in volume on a monthly basis than wastes generated during the Project operations phase, the time period of the construction phase is much shorter.

5.7.6.1.4 Summary

A summary of unmitigated potential impacts of Project construction activities on regional waste management is provided in Table 5-43.

Table 5-43 Summary of unmitigated potential impacts on waste management during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Improperly stored waste leading to potential increase in vermin around waste storage areas and the consequent increase in availability of prey for carnivorous birds and mammals	Low	Medium	Minor	N
Transport of hazardous wastes offsite leading to contamination of agricultural land and/or groundwater aquifers.	Low	Medium	Minor	N

5.7.6.2 Pre-commissioning and commissioning phase

The unmitigated potential impacts during pre-commissioning and commissioning phases are expected to be similar to the operations phase impacts (see Section 5.7.6.3 below).

5.7.6.3 Operations phase

5.7.6.3.1 Baseline context and receptor sensitivity

See Section 5.7.6.1. The sensitivity of humans to the possible presence of vermin or disease vectors is considered **medium**.

5.7.6.3.2 Project aspects

All operations and utilities and Project administration.

5.7.6.3.3 Magnitude of potential impacts

All operational waste will be managed in accordance with Pearl Petroleum's Waste Management Procedure (WMP) and Waste Management Facilities Project Charter. Non-hazardous wastes will be segregated and stored in designated locations until a suitable time allows for incineration (on-site) or recycling (on or offsite); alternatively, they will be sent to an approved offsite waste disposal facility. The possible impact magnitude on regional waste storage capacity is considered **low** as the volume generated is not expected to be high. This gives a significance rating of **minor**.

The possible impact of incineration is described in Section 5.7.1.

Any hazardous process waste materials that cannot be reused or recycled on-site will be stored on-site or managed offsite if facilities for such substances exist within the KRI, in accordance with the provisions of the WMP, and applicable MNR legal and regulatory requirements. Waste stored on-site will be managed according to international standards. The possible attraction of vermin and disease vectors therefore has been assigned an impact magnitude of **low**, giving an impact significance rating of **minor**.

Liquid hazardous waste, such as water produced from plant operations, may include hydrocarbons or synthetic formulations (for example used oils), methanol and corrosion inhibitor leading to potential impact on soil and water resources. Without mitigation, this could give rise to negative impacts, as described in Sections 5.7.2 and 5.7.3).

Wastewater from accommodation and offices could also leading to potential impacts on soil and groundwater. Without mitigation, this could give rise to a **minor** impact.

The potential impacts of transport of hazardous wastes offsite are similar to those raised for the construction phase (see Section 5.7.6.1).

5.7.6.3.4 Summary

A summary of unmitigated potential impacts of waste management during the Project operations phase is presented in Table 5-44.

Table 5-44 Summary of unmitigated potential impacts on waste management during operations

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Strain on existing landfills due to the generated non-hazardous solid wastes	Low	Low	Slight	N
Improperly stored waste leading to potential increase in vermin around waste storage areas and the consequent increase in availability of prey for carnivorous birds and mammals	Low	Medium	Minor	N
Transport of hazardous wastes offsite leading to contamination of agricultural land and/or groundwater aquifers.	Low	Medium	Minor	N

5.7.6.4 Decommissioning phase

5.7.6.4.1 Baseline context and receptor sensitivity

See Section 5.7.6.1.

5.7.6.4.2 Project aspects

At the end of the lifetime of the KM250A Project infrastructure it will be decommissioned, aboveground infrastructure removed and the area rehabilitated to a suitable standard to be agreed with MNR and, as appropriate, local stakeholders.

Decommissioning of the facilities and equipment will generate both primary materials used to construct the Project (i.e. concrete, steel etc.) and hazardous waste (i.e. oily rags, contaminated soil or spill kit materials etc.). Hazardous wastes generated may include:

- liquid and solid contents and wastes from decommissioned equipment
- used spill kits/oily rags
- waste oil/oily water from drip trays
- wastewater.

5.7.6.4.3 Magnitude of potential impacts

During the decommissioning phase it is proposed that materials/equipment be recycled and reused where possible before disposing of the residual waste in an attempt to reduce pressure on existing landfill sites. Consequently, the expected impact from decommissioning waste in terms of regional landfill capacity without suitable mitigation measures in place is expected to give rise to **moderate** impacts.

Hazardous waste will be segregated and disposed of in accordance with applicable regulations and the WMP. The volumes of hazardous waste generated are expected to be low as it is intended that most of the materials salvaged from the decommissioned facility will be recycled. The adverse impact from spills of wastes generated on the surrounding environment is described in Sections 5.7.2 and 5.7.3.

5.7.6.4.4 Summary

A summary of unmitigated potential impacts of waste management during the decommissioning phase is presented in Table 5-45.

Table 5-45 Summary of unmitigated potential impacts on waste management during decommissioning

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Generation and accumulation of solid wastes (i.e. materials and equipment) during decommissioning.	Medium	Medium	Moderate	Y

5.7.7 Socio-economic

5.7.7.1 Construction phase

5.7.7.1.1 Local economy

Baseline context and receptor sensitivity

The communities in the AOI are predominantly small in population, with the majority consisting of fewer than 100 residents. Some of the Project-affected communities (PACs) have experienced population growth due to the return of residents who had migrated from the area during the years of the Baathist regime or for economic reasons (e.g. to re-engage in former livelihood activities such as crop farming and livestock rearing). Others have experienced population decline due to a lack of employment opportunities and access to basic services. The populations of the PACs remain highly mobile; a number of part time households (i.e. households which, for various reasons, are absent from the PACs at certain times in the year) were identified in the communities during primary baseline data collection.

Whilst there is a very low level of business and enterprise development in the AOI, work at the existing facility is frequently outsourced to third party contractors and sub-contractors, many of whom are local to the area. The availability of alternative business opportunities for these companies within the AOI is limited, resulting in fierce competition between local companies over contracting opportunities with Pearl Petroleum.

Households in the PACs enjoy some disposable income, marked by the ownership of consumer goods such as mobile phones, televisions and fridges. In the absence of locally available goods and services, PAC members typically purchase daily necessities and other household items from locations outside the AOI, particularly cities such as

Chemchemal and Kirkuk. The majority of PACs are also engaged in crop farming and/or livestock rearing; a proportion of the outputs associated with these activities (e.g. crops, livestock produce) are consumed by the household for subsistence purposes.

The sensitivity of this receptor is considered to be **high**.

Project aspects

It is estimated that between 500 and 1,000 workers may be required during the construction phase, with the possibility of more workers during the peak construction period.

There will be opportunities for local companies to win contracts to supply goods and services to the Project.

Magnitude of potential impacts

Companies participating in the Project supply chain will benefit economically during the construction phase. There will be opportunities to win contracts providing goods and services to, for example, the construction camp as well as to supply construction materials. Project-related procurement from local businesses will generate multiplier effects across the local economy. This impact is **positive**.

The economic opportunities generated by the Project may lead to inflation in the price of basic goods and services. Given that PAC members have a certain level of disposable income, tend to travel outside the AOI to purchase daily goods and necessities and produce some of their own food through livelihood activities such as crop farming and livestock rearing, the magnitude of this impact is **low.** However, vulnerable groups (people living with physical and/or mental impairments, female-headed households, internally displaced people and elderly widows) may be particularly sensitive to this impact, owing to issues such as low incomes, high unemployment and lack of assets (e.g. land).

The generation of employment and other opportunities associated with the Project has the potential to stimulate in-migration (influx) into the AOI. This could potentially lead to conflict between economic migrants and the local population as well as competition for land, housing and basic services such as schools and medical facilities, many of which are already under-resourced and over-stretched. The provision of some basic services (e.g. water and electricity) by Pearl Petroleum in some of the PACs risks further encouraging in-migration. Baseline data indicates that operations at the existing facility has not stimulated in-migration into the AOI to date. Nevertheless, the potential for influx as a result of the Project remains. The magnitude of this impact is **medium**.

Summary

The significance of potential impacts prior to mitigation are summarised in Table 5-46.

Table 5-46 Summary of unmitigated potential impacts on the local economy unmitigated during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Opportunities for local and regional businesses to supply goods and services to the Project, generating multiplier effects across the local economy.	Positive	High	Positive	N
Local price inflation indirectly arising from economic opportunities generated by the Project, leading to increased living costs for PAC members.	Low	High	Moderate	Y
Project-induced in-migration, leading to increased competition for land, housing and basic services.	Medium	High	High	Y

5.7.7.1.2 Employment and skills development

Baseline context and receptor sensitivity

Unemployment rates in the PACs are high. Approximately 80% of household members were unemployed at the time of the household survey, of whom 69% were actively seeking work.

Literacy rates in the PACs are low relative to the KRI as a whole; in some communities, only 60 to 65% of residents are literate, compared to an average of literacy rate of 79% at the regional level.

Pearl Petroleum is a particularly important source of formal employment in the PACs; alternative employment opportunities are scarce, with a small number of PAC members finding employment as civil servants, for example teachers, Peshmergas (military personnel) and Asayish officers (members of the local police force). As a result, expectations of the Project's ability to provide local employment opportunities are high and competition for jobs is fierce. The belief that Pearl Petroleum should give priority to local people and businesses with respect to economic opportunities is common across the PACs Some PACs believe they are more entitled to employment opportunities than other PACs, based on their closer proximity to the existing facility. An established recruitment process is in place at the existing facility. Personnel are recruited based on their suitability for the work, governed by factors such as education, experience, skills and other attributes (CPDG, 2019f). The Sub-District Manager is engaged in, and agrees with, Pearl Petroleum's distribution of employment opportunities across the local communities. Contractors and sub-contractors are required to honour this agreement.

The sensitivity of this receptor is considered to be **high**.

Project aspects

It is estimated that between 500 and 1,000 workers may be required during the construction phase, with the possibility of more workers during the peak construction period.

It is anticipated that employment will be of a temporary nature and that a large proportion of the construction workforce will be released at the end of construction.

Magnitude of potential impacts

People from the PACs and the wider region will have the opportunity to benefit from direct and indirect employment opportunities associated with the Project. Increased incomes will lead to improvements in household living standards and well-being. This impact is **positive**.

Construction workers will receive on-the-job training in areas such as occupational health and safety (OHS) and basic construction activities. Despite the temporary nature of employment during construction, the skills and experience gained by construction workers during this period will improve their health and safety awareness and enhance their future employment prospects. It will also help to strengthen the OHS culture amongst the local workforce. This impact is **positive**.

There is potential for the recruitment of workers from the AOI and wider region by the Project to lead to skills shortages in other sectors. Those working in the public sector, for example, may be attracted by Project-related employment opportunities, particularly if the salaries associated with these jobs are more favourable. This may in turn have negative outcomes for the quality of public service provision if public sector workers find employment with the Project and are not replaced. Those who are unable to afford services provided by the private sector, such as private education and private health care, may be particularly sensitive to this impact. The magnitude of this impact is **medium**.

There is the potential for unmet expectations of Project-related benefits to lead to dissatisfaction within the PACs (e.g. due to the number of employment opportunities available relative to demand or due to discrepancies between the skills required to secure employment and the skills available locally). This could lead to grievances and a general loss of support for the Project amongst the PACs which, if not addressed satisfactorily, could lead to road blocks and other forms of protest. The magnitude of this impact is **high**.

There is potential for tensions to arise between those who benefit economically from the Project and those who do not. Tensions may arise between PACs as well as within households or between individual PAC members if economic opportunities are, or are perceived to be, unfairly distributed. There is a strong belief amongst community members that they should be given priority for jobs over individuals from other parts of the district and wider region. Therefore, tensions may also arise between the local population and non-local workers recruited from outside the AOI. If not adequately addressed, tensions could deteriorate further other time and lead to conflicts between groups. The magnitude of this impact is **high**.

The majority of local employment will occur during construction; a large proportion of the workforce will be released when this phase of the Project is complete. The retrenchment of workers at this stage has the potential to lead to economic shock and a decline in living standards at the household level if suitable preparations for the termination of employment contracts are not made[24]. Employees may also feel dissatisfied with Pearl Petroleum, particularly if the notice period for retrenchment is, or is perceived to be, inadequate, potentially leading to road blocks and other forms of protest. The magnitude of this impact is **high**.

Summary

The significance of potential impacts prior to mitigation are summarised in Table 5-47.

Table 5-47 Summary of unmitigated potential impacts on employment and skills development during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Project-related employment opportunities, leading to an improvement in household living standards and well-being.	Positive	High	Positive	N
Project-related training opportunities, leading to improved OHS awareness and the enhancement of future employment prospects.	Positive	High	Positive	N
Project-related employment opportunities, leading to skills shortages in other sectors.	Medium	High	High	Y
Unmet expectations, leading to dissatisfaction and loss of support for the Project amongst PACs.	High	High	Major	Y
Tensions between those who benefit economically from the Project and those who do not leading to conflict.	High	High	Major	Y
Retrenchment of workers, leading to economic shock and reduced living standards at the household level.	High	High	Major	Y

5.7.7.1.3 Labour and working conditions

Baseline context and receptor sensitivity

The enforcement of labour rights in line with international conventions and national and regional legislation in the KRI is limited; awareness of labour rights and OHS amongst employers and employees is low (Qadr *et al*., 2016). Many workers in the region lack employment contracts and violations of working hours, overtime and holiday leave are widespread (Qadr *et al*., 2016). There is a culture of non-compliance by companies with existing OHS regulations, which can be attributed to several factors, including the lack of punishment for non-compliance and a perception (amongst some companies) that OHS measures are a financial burden. In rural parts of the KRI, there is a tendency for small entrepreneurs (e.g. plumbers, carpenters) to take their children to work in order to learn the skills associated with their parents' trade.

[24] It is possible that future facility expansion will reduce the scale of retrenchment, but no details are currently available. Therefore, this cannot be considered in the assessment of impact significance.

Work at the existing facility, in fields such as construction and transportation, is typically outsourced to contractors and sub-contractors. Pearl Petroleum has established systems in place in order to manage the potential risk of labour rights violations occurring amongst existing contactors.

The sensitivity of this receptor is considered to be **high**.

Project aspects

It is estimated that between 500 and 1,000 workers will be required during the construction phase, with the possibility of more workers during the peak construction period. The vast majority of employment will be conducted through contractors and sub-contractors; working hours will be flexible and will vary according to season/local weather conditions.

Non-local workers (from other parts of Kurdistan or further afield) will be housed in a construction camp located within the boundary of the existing facility; the construction camp will be designed, built and operated in align with IFC/EBRD requirements (considering issues such as a safe and healthy location, the application of appropriate construction standards, the provision of adequate and sanitary living conditions and the provision of appropriate leisure and health facilities).

Construction works will be located both within and outside of the boundary of the existing facility, including along up to five additional flowlines that are to be installed.

Magnitude of potential impacts

There is the potential for labour rights violations to occur within the Project supply chain during the construction phase, leading to negative impacts on workers' health and well-being. Violations may include discriminatory recruitment and employment practices, unfair treatment or exploitation of workers, failure to issue employment contracts, excessive working hours, lack of payment and other entitlements (e.g. sick leave) and child labour. The risk of these violations occurring is particularly high where companies contracted by the Project outsource their work to sub-contractors as the activities of these companies tend to be less visible and are therefore more difficult to monitor. The magnitude of this impact is **high**.

There is potential for contractors and sub-contractors to fail to meet international standards on OHS. There are generally low levels of health and safety awareness in the PACs, including awareness of the right to a safe and healthy workplace. Failure to honour international standards on OHS during Project construction will increase the risk of workplace accidents occurring, leading to the injury, permanent incapacity and potential mortality of workers. The magnitude of this impact is **high**.

Unequal working conditions and disparities in renumeration may lead to tensions within and/or between different groups of workers, including those who come from the PACs, those who come from the wider region (i.e. other parts of Kurdistan) and those who come from other countries (i.e. expatriates). If disregarded, tensions could deteriorate further over time and lead to conflicts between different members of the workforce. In the absence of proper management, there is also the potential that discrepancies in working conditions and wages may lead to grievances and a general loss of support for the Project amongst workers from the PACs, potentially resulting in road blocks and other forms of protest. The magnitude of this impact is **high**.

Summary

The significance of potential impacts prior to mitigation are summarised in Table 5-48.

Table 5-48 Summary of unmitigated potential impacts on labour and working conditions during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Labour rights violations in the Project supply chain, leading to negative impacts on workers' health and well-being.	High	High	Major	Y
Failure to meet international OHS standards by contractors and sub-contractors, leading to increased risk of workplace accidents.	High	High	Major	Y
Tensions within and/or between different groups of workers resulting from disparities in wages and working conditions, leading to conflict.	High	High	Major	Y

5.7.7.1.4 Land access and livelihoods

Baseline context and receptor sensitivity

Agricultural activities such as crop farming and livestock rearing are the main sources of livelihood and income in the PACs. A small number of PACs also rely on the harvesting of natural resources such as rainwater, freshwater, wild plants and grasses. Whilst some households have diversified livelihood strategies, others rely solely on agriculture for income and have lower resilience to external shocks such as crop failure.

Grazing land is essential for those with livestock, with some livestock rearers travelling up to 5 km to access pasture land. Access to water for livestock relies on groundwater wells and, to a lesser extent, ponds and seasonal springs. Challenges with regards to the availability of water for livestock rearing have increased in recent years due to increased drought frequencies and declining levels of groundwater resources.

Issues surrounding land access and ownership in the AOI are contentious and complex. Land ownership is predominantly based on traditional land rights whereby PAC members inherit land from elderly family members. The majority of land owners, however, do not possess formal documentation (e.g. title deeds) proving their ownership of the land. Within the AOI, land-related conflicts have occurred over the demarcation of land boundaries and/or livestock trespassing on land that is owned by other households; the majority of conflicts are not severe, being typically resolved between those concerned within hours or couple of days. Some PAC members are dissatisfied with previous processes of land acquisition and compensation at the existing facility (Section 3.4.9.6.1).

The sensitivity of this receptor (land owners, households whose livelihood depends on farming or livestock rearing) is considered to be **high**.

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Project aspects

The construction of up to five additional flowlines external to boundary of the existing facility, which will require additional land not currently used by the Project and the imposition of access restrictions during construction.

Magnitude of potential impacts

The construction of new flowlines external to the boundary of the existing facility will lead to the temporary loss of access to land used for livelihood activities such as crop farming, livestock rearing and the collection of natural resources (e.g. grass and vegetation for livestock). Given the limited availability of formal employment opportunities in the AOI, agricultural activities such as crop farming and livestock rearing are vital income-generating activities. Households may experience a decrease in income, food security and living standards. Households which are solely reliant on agriculture and lack alternative sources of income may be particularly sensitive to this impact. The magnitude of this impact is **high**.

Land acquisition and compensation for loss of crops and pasture land has the potential to exacerbate existing conflicts over land and/or generate new ones. Conflicts over land have occurred within and between the PACs in the past and some PAC members remain dissatisfied with previous processes of land acquisition and compensation at the existing facility. Dissatisfaction with the handling of land acquisition and compensation for the Project may also lead to a general loss of support for the Project, potentially resulting in roadblocks and other forms of protest. Given that conflicts between land users are predominantly non-severe and quickly resolved, the magnitude of this impact is **medium**.

The construction of new flowlines may form a barrier that temporarily disrupts access to watering wells and pastureland for livestock. Barriers can be formed by piles of soil from RoW clearing, strung pipe or fences surrounding open trenches. This may impact upon the livelihoods of households engaged in livestock rearing. Households that are solely reliant on livestock rearing and lack alternative sources of income may be particularly sensitive to this impact. Disrupted access to watering wells and pastureland may also increase pressure on alternative pasture land and watering wells, potentially resulting in conflict between users. The magnitude of this impact is **medium**.

Activities (e.g. excavation works) during the construction period may increase the risk of accidents involving livestock. Animals could, for example, fall into open trenches, resulting in injury and potential mortality. Loss of livestock will in turn have an impact upon household income, food security and living standards. Households which have small herds and/or lack additional sources of income to livestock rearing will be particularly sensitive to this impact. The magnitude of this impact is **medium**.

Summary

The significance of potential impacts prior to mitigation are summarised in Table 5-49.

Table 5-49 Summary of unmitigated potential impacts on land access and livelihoods during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation Required (Y/N)
Temporary loss of access to land used for crop farming, livestock rearing and natural resource harvesting, leading to decreased income, food security and living standards.	High	High	Major	Y
Exacerbation of existing conflicts and/or generation of new conflicts during the Project land acquisition and compensation process, leading to loss of support for the Project.	Medium	High	High	Y
Temporary reduction in access to watering wells and pastureland for livestock, leading to loss of livelihood and increased pressure on alternative pasture land and watering wells.	Medium	High	High	Y
Accidents involving livestock, leading to injury and potential mortality.	Medium	High	High	Y

5.7.7.1.5 Community safety and security

Baseline context and receptor sensitivity

The presence of Peshmerga and Asayish officers, alongside private security personnel and the Oilfield Protection Force at the existing facility, contributes to high levels of security in the AOI. Rates of crime and anti-social behaviour are low.

A general sense of peace and stability exists within the PACs, which are predominantly close-knit and consist of residents who are either local to the area or who have been in the area for a long time.

The Qadir Karam sub-district where the Project will be based has a total of 43 cleared minefields, four ongoing minefield clearances and nine minefields still to be cleared. Minefields still to be cleared have been marked for safety reasons and are located some distance from the facility and to the southwest of the Project site.

Existing traffic levels in the AOI are low and road traffic accidents were not identified as a major threat to community safety during primary baseline data collection. Nevertheless, vehicle collisions are amongst the leading causes of injury and mortality across the KRI as a whole and hence the safety risks associated with such incidents remain. Road crossings near to schools were reported to be high-risk areas by teachers from schools in the AOI, owing to the absence of speed reduction measures (e.g. speed bumps) and traffic warning signs.

Non-local workers at the site are normally housed at and restricted to the site, so there is little or no contact with local communities. Nonetheless, such contact would engender risk by local residents, such that their sensitivity to such contacts is considered **high**. The sensitivity of local stakeholders that are at risk with respect to traffic accidents is considered to be **high**. Sensitivity to the presence of security personnel is also rated **high**.

Project aspects

The construction of the Project will require the transportation of goods, materials and personnel to and from work sites; there are sensitive social receptors, including residential areas, schools, and mosques, graveyards and other tangible cultural heritage locations, along main transportation routes.

Construction of up to five additional flowlines external to the boundary of the existing facility, requiring the mobilisation of equipment and undertaking of activities such as trenching.

The existing facility is fenced and equipped with 24-hour security measures in order to ensure the safety of staff and physical assets.

Magnitude of potential impacts

Construction external to the boundary of the existing facility may increase the risk of accidents involving community members. Inadequate control of access to work sites may result in the community gaining entry and sustaining injuries from interactions with construction equipment and materials or by falling into open trenches. In previous construction projects, children have been particularly vulnerable to this impact. The magnitude of this impact is **high**.

An increase in the volume of traffic on the local road network during the construction period may lead to an increase in the risk of road traffic accidents involving community members. Children and teachers may be particularly sensitive to this impact due to the lack of speed reduction measures and road signs near schools in the AOI, although the access route land use survey indicated that only houses were within the 150m AOI on either side of the routes surveyed.[25] The magnitude of this impact is **high**.

The recruitment of non-local workers (from other parts of Kurdistan or further afield) during the construction period may lead to tensions with members of the PACs. Whilst these workers will be housed in a construction camp located within the boundary of the existing facility, they may possess different cultural values from the PACs and their lack of local social ties may result in anti-social and/or culturally inappropriate behaviour towards PAC members. If disregarded, tensions could deteriorate further over time and lead to conflicts between non-local workers and PAC members. Women, children, people living with physical and/or mental impairments and the elderly may be particularly sensitive to this impact. The magnitude of this impact is **medium**.

During the construction period, PAC members may approach Project work sites in search of employment or for other reasons. This may lead to negative interactions with security personnel responsible for protecting work sites and implementing safety measures. The use of inexperienced or inadequately trained security personnel may lead to conflict and potentially the inappropriate use of force. The magnitude of this impact is **medium**.

Dissatisfaction amongst PAC members, with regards to the handling of social issues by the Project (e.g. employment and business opportunities or land acquisition and compensation procedures) may lead to a loss of support for the Project and an increase

[25] For example, according to the access route land use survey conducted within the framework of this ESIA, Khor Mor Gawra is situated approximately 170 m away from the main transportation road, west of the Project site. The PAC is surrounded by agricultural and grazing lands with barns, on both sides of the route. There is also a graveyard and Khor Mor Gawra Primary School along the main road. At Shekh Hameed, there is a school and mosque near the roadside.

in the number of roadblocks and other forms of protest across the AOI. Baseline data indicates that such events have been staged by members of the PACs in relation to activities at the existing facility in the past. An increase in roadblocks and other forms of protest may contribute to an increased security presence in the AOI and a reduction in the overall sense of peace and stability in the PACs. The magnitude of this impact is **medium**.

The flaring of gas during non-routine events may lead to anxiety, irritation and a reduction in the overall well-being of PAC members associated with perceived impacts to their health. Individuals living with underlying mental health conditions will be particularly sensitive to this impact. The magnitude of this impact is **medium**.

Summary

The significance of potential impacts prior to mitigation are summarised in Table 5-50.

Table 5-50 Summary of unmitigated potential impacts on community safety and security during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation Required (Y/N)
Increased risk of accidents involving community members at work sites, leading to injury and potential mortality.	High	High	Major	Y
Increased volume of traffic, leading to an increased risk of road traffic accidents involving community members.	High	High	Major	Y
Tensions between non-local workers and members of the PACs, leading to conflict.	Medium	High	High	Y
Negative interactions between community members and Project security personnel, leading to conflict and potentially the inappropriate use of force.	Medium	High	High	Y
Dissatisfaction with the handling of social issues by the Project amongst PAC members, leading to an increase in the number of road blocks and other forms of protest.	Medium	High	High	Y
Anxiety, irritation and a reduction in overall well-being amongst the PACs resulting from gas flaring during non-routine events.	Medium	High	High	Y

5.7.7.1.6 Public Health

Baseline context and receptor sensitivity

Health problems in the PACs include flu-like symptoms (e.g. sore throats, fevers), diarrhoea and respiratory conditions (e.g. asthma). Respiratory conditions were not regarded as being connected to environmental issues such as poor air quality locally. Non-communicable diseases (NCDs) such as diabetes and high blood pressure are common, particularly amongst the elderly generation, reflecting the predominance of NCDs at the regional level. A minority of PAC members are living with mental illnesses and physical disabilities. The majority of PAC members seek medical assistance from health facilities with a small number relying on alternative treatment options (e.g. self-medication, traditional medicine).

The sensitivity of this receptor is considered to be **medium**.

Project aspects

It is estimated that between 500 and 1,000 workers may be required during the construction phase, with the possibility of more workers during the peak construction period.

Non-local workers (from other parts of Kurdistan or further afield) will be housed in a construction camp located within the boundary of the existing facility; local workers will be recruited from the PACs and will commute to the site using local roads on a daily basis.

All construction activities involving the emission of noise, pollution, dust and waste by the Project could potentially impact baseline health conditions in the AOI.

Magnitude of potential impacts

The recruitment of non-local workers (e.g. from other parts of Kurdistan or further afield) during the construction period has the potential to lead to the transmission of communicable diseases between these workers and members of the local workforce from the PACs. Communicable diseases may in turn be transmitted by local workers to PAC members as they interact with relatives, friends and neighbours, impacting upon health and well-being at the community level. Children, the elderly and persons living with a compromised immune status may be particularly sensitive to this impact. The transmission of communicable diseases may also lead to increased pressure on local health care facilities. The magnitude of this impact is **medium**.

There is the potential that an increase in ambient noise levels during the construction period (e.g. due to increased traffic volumes, the operation of construction equipment) may lead to anxiety, irritation and a reduction in the overall well-being of PAC members. Individuals living with underlying mental health conditions will be particularly sensitive to this impact. The magnitude of this impact is **medium**.

There is the potential for a decline in local air quality due to combustion emissions generated by construction activities to lead to an increase in respiratory conditions or exacerbate existing respiratory conditions in the PACs. The elderly and children will be particularly sensitive to this impact. The magnitude of this impact is **medium**.

Summary

The significance of potential impacts prior to mitigation are summarised in Table 5-51.

Table 5-51 Summary of unmitigated potential impacts on public health during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation Required (Y/N)
Transmission of new communicable diseases between the non-local and local Project workforce, leading to a reduction in health and well-being at the community level and increased pressure on local health care facilities.	Medium	Medium	Moderate	Y
Anxiety, irritation and reduced well-being amongst PACs resulting from an increase in ambient noise levels.	Medium	Medium	Moderate	Y
Increase in respiratory conditions or exacerbation of existing respiratory conditions resulting from a decline in local air quality.	Medium	Medium	Moderate	Y

5.7.7.1.7 Infrastructure and services

Baseline context and receptor sensitivity

Water is a highly sensitive and important issue in the AOI. Problems with the quality, quantity and reliability of water are common across the PACs with implications for the livelihoods, health and well-being of PAC members. Challenges surrounding water are reported to have intensified in recent years as a result of drought periods and the declining availability of groundwater in local wells.

Electricity is the main source of energy for lighting in the majority of the PACs, accounting for approximately three quarters (76%) of the households interviewed during primary baseline data collection. Schools and health care facilities similarly rely on electricity to provide public services, though issues with the reliability of electricity supply were reported by some facilities, reflecting trends across the KRI more generally. The remainder of the households interviewed (24%) derive electricity from privately owned generators powered by diesel. Some PACs and households have no access to electricity and rely on traditional energy sources (e.g. candles, oil lamps) for lighting. Improved electricity supply is a common aspiration locally.

Health services in the AOI are under-resourced and over-stretched. Existing facilities face challenges in relation to their ability to meet local demand and the quantity of medical supplies available.

The disposal of solid waste at designated waste collection points is the main method of waste disposal in the PACs; some households burn solid waste in private waste pits. The adequacy of existing waste management infrastructure in the AOI is a challenge, particularly in the larger PACs, where the dumping of waste in open areas takes place.

PACs typically rely on the existing road network to commute to settlements outside the AOI for health care, education, the purchasing of goods and services, the sale of agricultural produce and (in a minority of cases) employment. There are no public transportation networks (e.g. buses). Local road conditions vary significantly from good asphalt paved roads, to high-grade and low-grade gravel roads, down to dirt roads in very poor condition. The volume of traffic on the local road network is highest between the hours of 08:00 – 10:00 and 14:00 – 16:00.

The sensitivity of the respective receptors in relation to provision of the above infrastructure and services is considered to be **high**.

Project aspects

The construction of the Project will rely on the use of the local road network to transport goods, materials and personnel to and from work sites.

Waste generated by construction activities will be managed by the Project and will not rely on local waste management infrastructure

Requirements for water will be managed by the Project and will not rely on water sources in the PACs.

The medical needs of contractor and sub-contractor employees will be met by the Project and will not require assistance from local health facilities.

Bridges may need to be upgraded and electricity pylons may need to be moved to allow access for Project vehicles.

Magnitude of potential impacts

The transportation of materials, equipment and personnel will lead to an increase in the volume of traffic on the local road network during the construction period, including HGVs. This may lead to a deterioration in existing road conditions, which may in turn cause damage to vehicles, result in longer journey times and increase the risk of accidents for local people. The magnitude of this impact is **medium**.

Whilst the waste generated by construction activities will be managed by the Project (see Section 5.7.6), there is potential for improper handling and disposal of waste, particularly amongst sub-contractors. This may lead to a deterioration in local environmental conditions and the spread of diseases where water sources become contaminated by Project-related oils, metals and sanitary waste. The contamination of local water resources by sanitary waste is a particular concern given that related illnesses (e.g. diarrhoea) are already one of the main health problems experienced in the PACs. Children, the elderly and persons living with a compromised immune status may be particularly sensitive to this impact. The magnitude of this impact is **medium**.

Whilst the Project will provide medical assistance to contractor and sub-contractor employees, the potential for these staff (particularly those working for sub-contractors) to seek treatment from local health services outside working hours remains. This may increase pressure on existing facilities in the AOI, which are already under-resourced and over-stretched, leading to negative outcomes for health care provision for the PACs. The magnitude of this impact is **medium**.

Whilst Project requirements for water will not reduce access to water in the PACs, problems associated with the quantity and quality of water available in the PACs were reported during primary baseline data collection. Therefore, there is the potential for the Project to be incorrectly blamed on reduced access to water by PAC members. This may in turn lead to a general loss of support for the Project, potentially resulting in roadblocks and other forms of protest. The magnitude of this impact is **medium**.

During the construction period, bridges may need to be upgraded and electricity pylons may need to be moved to allow access for Project vehicles. There is also the potential for accidental damage to power lines or other community infrastructure. Upgrading, movement or damage to such infrastructure may lead to loss of access and/or power for households and public services (e.g. schools and health care facilities). Given that problems with power supply are commonly experienced by some of the households, schools and health care facilities in the AOI, the magnitude of this impact is **medium**.

Summary

The significance of potential impacts prior to mitigation are summarised in Table 5-52.

Table 5-52 Summary of unmitigated potential impacts on infrastructure and services during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation Required (Y/N)
Deterioration in existing road conditions, leading to vehicle damage, longer journey times and increased risk of accidents for local people.	Medium	High	High	Y
Improper handling and disposal of Project waste, leading to a deterioration in environmental conditions and potential outbreak of diseases.	Medium	High	High	Y
Use of local health services by contractor and sub-contractor employees, leading to negative outcomes for health care provision for the PACs.	Medium	High	High	Y
Blame directed towards the Project by PAC members over perceived reduction in access to water, leading to loss of support for the Project.	Medium	High	High	Y
Upgrading, movement or damage to community infrastructure, leading to loss of access and/or power for households and public services.	Medium	High	High	Y

5.7.7.1.8 Cultural heritage

Potential impacts on cultural heritage within the Project cultural heritage AOI is only expected during the construction phase of the Project.

Baseline context and receptor sensitivity

The cultural heritage baseline (see Section 3.4.12) indicated that tangible cultural heritage sites within the cultural heritage AOI include cemeteries, villages destroyed during the war (preserved *in memoriam*), graveyards, shrines and mosques. There are also various archaeological sites identified in previous studies, mostly to the west, southeast, south and southeast of the main Khor Mor site, although there is one site close to one of the proposed new flowline routes (Sarcham Tepe, thought to date at the earliest from the Sumerian Early Dynastic, Akkadian and New Sumerian periods, 3000 to 2000 B.C).

Very little is known about the Sarcham Tepe site. As a precaution, the sensitivity of this site is considered to be **medium**.

Intangible cultural heritage within the cultural heritage AOI include various festivals (largely in March or April, although they do not occur every year), as well as wedding celebrations that can last three days. The sensitivity of these events is considered to be **medium**.

Project aspects

Project activities related to installation of the new flowlines could have an impact on one of the identified archaeological sites, although very little is known about that site.

All Project activities implemented during the construction phase could potentially affect the existing baseline conditions of cultural events (especially in March or April).

Magnitude of potential impacts

There is the potential for damage of the existing cultural heritage site near the expected route of one of the flowlines during installation of flowlines to. However, little is known about this site, and it appears to only have local value. Furthermore, Pearl Petroleum corporate policy requires that the Chance Finds Procedure be applied to all construction activities. The magnitude of this impact is **slight**.

If construction activities (including work on the flowlines, work at the main KM250A Project site, and construction traffic along local access roads) occur during intangible cultural heritage events, the Project activities may cause interference (noise in particular), depending on the location of these events. The magnitude of this impact is **low**.

Summary

The significance of potential impacts prior to mitigation are summarised in Table 5-53.

Table 5-53 Summary of unmitigated potential impacts on cultural heritage during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation Required (Y/N)
Risk for cultural heritage artefacts or other evidence during earthworks/excavation	Slight	Medium	Slight	N
Risk for festivals, weddings and other intangible cultural heritage	Low	Medium	Minor	N

5.7.7.1.9 Traffic on access roads near the Project site

Baseline context and receptor sensitivity

Traffic surveys at key points along selected Project access roads indicate that local traffic is relatively limited and does not consist of heavy vehicles, aside from tanker trucks carrying condensate from the existing Khor Mor site to Chemchemal and some local HGVs (about 15% of afternoon traffic at certain locations during the traffic survey; these include trucks carrying scrap metal). The traffic survey indicated that local traffic is dominated by light vehicles. As noted earlier, the roads pass through various villages that contain residential areas, schools, a limited number of commercial zones, agricultural and livestock rearing facilities, mosques and other features. Some of the villages are near, but not on, main transportation routes. There are a limited number of alternative routes for local transport.

Some access roads are not designed to sustain heavy vehicles. Local roads are therefore rated **medium** in terms of sensitivity. The sensitivity of this receptor is considered to be **medium** in terms of inconvenience to users of the local road system.

Project aspects

Vehicle movements during construction have the potential to impact traffic on access roads.

Magnitude of potential impacts

The high level of Project traffic on access roads during the construction period are considered to have **high** impact magnitude within the local AOI in terms of safety risk to the PACs, potential interference with existing traffic, and possible deterioration of the existing road network (some of which is already in a degraded state) due to the additional volume of traffic and the use of HGVs.

Summary

The significance of potential impacts prior to mitigation are summarised in Table 5-54.

Table 5-54 Summary of unmitigated potential impacts on traffic during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation Required (Y/N)
Increased community safety risks from the frequent passage of tanker trucks leading to a higher number of injuries and fatalities.	See Section 5.7.7.1.5			
Interference with users of the public road network arising from temporary road closures and deviations.	High	Medium	High	Y
Deterioration of the physical condition of the public road network leading to vehicle damage, longer journey times and increased risk of accidents for local people.	High	Medium	High	Y

5.7.7.1.10 Visual impacts

The existing facility contains fractionation towers, flares and other structures that create visual impacts in relation to some of the sensitive receptors (see below). The KM250A Project will similarly feature some of the same infrastructure at height (the HP flare, for example, is 50 m in height); these will be installed during the construction phase. Furthermore, cranes will be located on-site during the construction phase (Table 5-32).

Baseline context and receptor sensitivity

The main sensitive receptors are the PACs located near the Project site and the permanent worker camp within the fenceline of the existing facility. Workers are accustomed to visual aspects of the existing facility. PAC members are likely to be accustomed to the presence of the kinds of structures that will be installed by the Project, so sensitivity to landscape changes and night lighting (which is used at the existing facility) in terms of additional tall structures is considered to be **low**. Although night lighting is already in place at the existing facility, a sensitivity ranking of **medium** has been assigned to the supplemental night lighting that will be active at Project construction sites (both within the existing facility fenceline and along the routes of the new flowlines during their installation).

Project aspects

Changes to landscape and visual impacts will occur during construction due to the physical presence of construction machinery, the workforce and perimeter fencelines. The existing Khor Mor operating facility has lighting at night for reasons of safety; this will be the case for the KM250A Project as well.

Light will be generated at night during construction by artificial lighting along perimeter fences and in working areas. A downlighting strategy will be used during construction and operations that will minimise the generation of light outside the perimeter area, so that harsh lights are not directed to people moving outside the Project boundaries.

Magnitude of potential impacts

The area surrounding the existing facility features small communities, people using local road networks, small farms and grazing. The additional site illumination may disturb sleep and other night-time activities. However, residents of nearby communities are used to experiencing the visual impacts arising from activities at the existing facility. Worker camps within the fenceline during the construction phase of the Project and permanent worker camps must also be taken into consideration, although both construction and permanent workers are used to such sites, and construction workers will be present for relatively short duration.

The magnitude of the impacts of construction activities (including lighting, whether at night or during the day) in terms of quality of life for local PACs and PAC members, taking into account downward facing lighting and other standard lighting approaches for reduction of impacts, is **low**.

Summary

The significance of potential visual impacts prior to mitigation are summarised in Table 5-55.

Table 5-55 Summary of unmitigated potential visual impacts during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation Required (Y/N)
Placement of construction equipment (including cranes) leading to disturbance of visual perspective by local stakeholders	Low	Low	Slight	N
Night lighting leading to disturbance of sleep and other night-time activities at local residences	Low	Medium	Minor	N

5.7.7.1.11 Vulnerable groups

Baseline context and receptor sensitivity

Vulnerable groups in the AOI include people living with physical and/or mental impairments, households with a significant proportion of elderly or young members, female-headed households, households facing unemployment which lack alternative sources of income, households which have been internally displaced, children from poor economic backgrounds and elderly widows. Challenges which are typically experienced by these groups and contribute to their vulnerability include reliance on others for income and support (particularly for people living with disabilities and elderly widows), high unemployment, low levels of literacy and lack of assets (particularly for female-headed households and households which have been internally displaced) and (for children from poor economic backgrounds) an inability to meet basic and educational needs. Support is provided by Pearl Petroleum to persons who are unable to read and write when applying for jobs at the existing facility.

Across all PACs, women and girls face challenges such as gender-based violence (GBV), forced marriage, high levels of illiteracy, lower levels of school attendance relative to boys and high rates of unemployment. Lack of education and cultural values/norms constrain access to employment and work opportunities for female PAC members considerably. Women typically fulfil a wide range of domestic roles at the household and community level, reinforcing their primary role as caregivers and homemakers.

The sensitivity of this receptor is considered to be **high**.

Project aspects

All Project activities implemented during the construction phase (as listed in Table 5-2) could potentially affect the existing baseline conditions of vulnerable groups and women.

Magnitude of potential impacts

There is the potential for vulnerable groups to struggle to access economic benefits arising from the Project (e.g. employment opportunities) due to barriers such as illiteracy, age, physical and/or mental disabilities and cultural values/norms. This may in turn exacerbate pre-existing vulnerabilities in the AOI and contribute to increased levels of inequality at the local level. The magnitude of this impact is **medium**.

There is the potential for women to struggle to access economic benefits arising from the Project (e.g. employment opportunities) due to barriers such as high levels of illiteracy and cultural values/norms. This may in turn contribute to increased levels of gender inequality at the local level. The magnitude of this impact is **medium**.

There is the potential that the employment of women by the Project may challenge existing power structures and social dynamics at the household and community levels, leading to an increase in conflict and GBV amongst households. The magnitude of this impact is **high**.

Vulnerable groups (e.g. female-headed households, people living with physical and/or mental impairments, elderly widows) may be unable to effectively engage and participate in the Project land acquisition and compensation process due to low levels of literacy, mobility issues or for other reasons. This may in turn lead to discrimination, exacerbate pre-existing vulnerabilities and contribute to greater levels of inequality in the AOI. The magnitude of this impact is **medium.**

Vulnerable groups may experience difficulties in accessing information about the Project due to factors such as lack of education, physical and/or mental impairments, age and cultural values/norms. This may in turn lead to lower levels of awareness about the Project and the potential benefits that may arise. Persons living with physical or mental disabilities may be unable to participate in Project-related engagement meetings or to raise questions. The magnitude of this impact is **medium**.

Women may experience difficulties in accessing information about the Project due to factors such as high levels of illiteracy; this may constrain their ability to understand Project-related presentations and written materials, leading to lower levels of awareness about the Project and the potential benefits that may arise. Women's role as primary caregivers and homemakers in the PACs may also constrain their access to Project-related information by limiting their opportunities to attend Project-related engagement meetings and voice concerns about the Project. Moreover, women are typically under-represented in meetings and decision-making at the community level, which may further constrain access to Project information. The magnitude of this impact is **medium**.

Summary

The significance of potential impacts prior to mitigation are summarised in Table 5-56.

Table 5-56 Summary of unmitigated potential impacts on vulnerable groups during construction

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation Required (Y/N)
Reduced ability of vulnerable groups to access Project-related economic benefits, leading to increased levels of vulnerability and inequality.	Medium	High	High	Y
Reduced ability of women to access Project-related economic benefits, leading to increased levels of gender inequality.	Medium	High	High	Y
Challenges to power structures and social dynamics as a result of women's employment by the Project, leading to an increase in conflict and GBV amongst households.	High	High	Major	Y
Reduced ability of vulnerable groups to effectively engage and participate in the Project land acquisition and compensation process, leading to discrimination and increased inequality.	Medium	High	High	Y
Reduced ability of vulnerable groups to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits.	Medium	High	High	Y
Reduced ability of women to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits.	Medium	High	High	Y

5.7.7.2 Pre-commissioning and commissioning phases

5.7.7.2.1 Baseline context and receptor sensitivity

See Section 5.7.7.2.1

5.7.7.2.2 Project aspects

See Section 5.7.7.2.2; also, flowline hydrotesting and commissioning (Sections 5.7.2.2 and 5.7.3.2.2).

5.7.7.2.3 Magnitude of potential impacts

The following potential socio-economic impacts, identified during construction, may also occur during the pre-commissioning and commissioning phases of the Project (unless otherwise noted):

Local economy (see Section 5.7.7.1.1)

- Opportunities for local and regional businesses to supply goods and services to the Project, generating multiplier effects across the local economy.
- Local price inflation indirectly arising from economic opportunities generated by the Project, leading to increased living costs for PAC members.

Employment and skills development (see Section 5.7.7.1.2)

- Project-related employment opportunities, leading to an improvement in household living standards and well-being.
- Project-related training opportunities, leading to improved OHS awareness and the enhancement of future employment prospects.
- Project-related employment opportunities, leading to skills shortages in other sectors.
- Unmet expectations, leading to dissatisfaction and loss of support for the Project amongst PACs.
- Tensions between those who benefit economically from the Project and those who do not, leading to conflict.
- Retrenchment of workers, leading to economic shock and reduced living standards at the household level.

Labour and working conditions (see Section 5.7.7.1.3)

- Labour rights violations in the Project supply chain, leading to negative impacts on workers' health and well-being.
- Failure to meet international OHS standards by contractors and sub-contractors, leading to increased risk of workplace accidents.
- Tensions within and/or between different groups of workers resulting from disparities in wages and working conditions, leading to conflict.

Community safety and security (see Section 5.7.7.1.5)

- Tensions between non-local workers and members of the PACs, leading to conflict.
- Negative interactions between community members and Project security personnel, leading to conflict and potentially the inappropriate use of force.
- Dissatisfaction with the handling of social issues by the Project amongst PAC members, leading to an increase in the number of road blocks and other forms of protest.

- Risk to safety of local residents of Project traffic (although this will be considerably less during pre-commissioning and commissioning than during the construction or operations phases).

Public health (see Section 5.7.7.1.6)

- Transmission of new communicable diseases between the non-local and local Project workforce, leading to a reduction in health and well-being at the community level and increased pressure on local health care facilities.
- Anxiety, irritation and reduced well-being amongst PACs resulting from an increase in ambient noise levels.

Infrastructure and services

It is anticipated that the hydrotesting of flowlines during the pre-commissioning and commissioning phases of the Project will require significant amounts of water (see Section 2.7). The wastewater resulting from this activity is expected to be held in large storage areas (ponds) and will not be suitable for human consumption. Problems associated with the quantity and quality of water available were commonly reported during primary baseline data collection. Therefore, whilst Project requirements for water will not reduce access to water in the PACs, there is the potential that PAC members will associate hydrotesting with issues surrounding local water quality and quantity. This may in turn lead to a general loss of support for the Project, potentially resulting in road blocks and other forms of protest. The magnitude of this impact is **medium**.

Other possible impacts concerning infrastructure and services were addressed in the construction section:

- Improper handling and disposal of Project waste, leading to a deterioration in environmental conditions and potential outbreak of diseases.
- Use of local health services by contractor and sub-contractor employees, leading to negative outcomes for health care provision for the PACs.

Vulnerable groups (see Section 5.7.7.1.11)

- Reduced ability of vulnerable groups to access Project-related economic benefits, leading to increased levels of vulnerability and inequality.
- Reduced ability of women to access Project-related economic benefits, leading to increased levels of gender inequality.
- Challenges to power structures and social dynamics as a result of women's employment by the Project, leading to an increase in conflict and GBV amongst households.
- Reduced ability of vulnerable groups to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits.
- Reduced ability of women to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits.

5.7.7.2.4 Summary

A detailed assessment of these impacts is presented in Section 5.7.7.1. These impacts, however, are expected to be less significant during pre-commissioning and commissioning compared to construction, owing to the fact that there will generally be less Project activity, and hence fewer workers, goods and services will be required and fewer Project activities will be taking place.

The significance of potential impacts related to infrastructure and services prior to mitigation are summarised in Table 5-57.

Table 5-57 Summary of unmitigated potential impacts on infrastructure and services during pre-commissioning and commissioning

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Association of hydrotesting with problems surrounding local water quality and quantity, leading to a loss of support for the Project amongst PAC members.	Medium	High	High	Y

5.7.7.3 Operations phase

5.7.7.3.1 Baseline context and receptor sensitivity

Kurdistan's regional economy is dependent on services, public administration and increasingly oil and gas production. The KRI has approximately 43.7 billion barrels of proven oil reserves and between three and six trillion cubic metres of gas (m^3), representing 30% of Iraq's proven oil reserves and 89% of all gas reserves nationwide (OPEC 2013 cited in Kamal 2018). With plentiful supplies, the oil and gas sector is regarded as integral to the region's economic development (PwC, 2018). The sensitivity of this receptor is considered to be **medium**.

See also Section 5.7.7.1.9 for baseline context and receptor sensitivity related to traffic on access roads near the Project site during construction.

See also Section 5.7.7.1.10 for baseline context and receptor sensitivity related to visual impacts during construction. PACs are likely to be sensitive to daytime flaring (to which a sensitivity ranking of **medium** has been assigned, and night-time flaring, to which a sensitivity ranking of **high** has been assigned).

5.7.7.3.2 Project aspects

Project aspects during the operations phase include:

- export of gas, LPG and condensate via pipelines or bulk transport
- requirements for chemicals and other raw materials
- permanent operations workforce and accommodation (80-100 people/rotational)
- maintenance activities
- Project traffic to and from the site on local access roads

- the presence of tall structures installed at the site adding to disturbance of well-being of residents of local communities
- generation of light at night by artificial lighting along perimeter fences and in working areas
- generation of light during routine operations from the flare pilots for two flare stacks (with heights of 50 m for the HP flare and 20 m for the LP flare)
- generation of noise and light during non-routine flaring events (impacts of noise generated during flaring events is addressed in Section 5.7.4.3).

5.7.7.3.3 Magnitude of potential impacts

Potential socio-economic impacts, identified during construction, may also occur during the operations phase of the Project. A detailed assessment of these impacts in relation to the construction phase is presented in Section 5.7.7.1. These impacts, however, are expected to be less significant during operations compared to construction, owing to the fact that there is generally less Project activity and hence fewer workers, goods and services will be required and fewer Project activities will be taking place.

The following potential socio-economic impacts, (unless otherwise noted) may also occur during the operations phase of the Project:

Local economy (see Section 5.7.7.1.1)

- Opportunities for local and regional businesses to supply goods and services to the Project, generating multiplier effects across the local economy.
- Local price inflation indirectly arising from economic opportunities generated by the Project, leading to increased living costs for PAC members.

Regional economy

- The operation of the Project will contribute to the development of the KRI's oil and gas sector and regional economic growth by increasing the production and sale of gas, LPG and condensate. It is anticipated that the export of products, procurement of goods and services and employment will contribute to regional energy supply and gross domestic product (GDP) during this period. This impact is **positive**.

Employment and skills development (see Section 5.7.7.1.2)

- Project-related employment opportunities, leading to an improvement in household living standards and well-being.
- Project-related training opportunities, leading to improved OHS awareness and the enhancement of future employment prospects.
- Project-related employment opportunities, leading to skills shortages in other sectors.
- Unmet expectations, leading to dissatisfaction and loss of support for the Project amongst PACs.
- Tensions between those who benefit economically from the Project and those who do not, leading to conflict.

Labour and working conditions (see Section 5.7.7.1.3)

- Labour rights violations in the Project supply chain, leading to negative impacts on workers' health and well-being.
- Failure to meet international OHS standards by contractors and sub-contractors, leading to increased risk of workplace accidents.
- Tensions within and/or between different groups of workers resulting from disparities in wages and working conditions, leading to conflict.

Land access and livelihoods

Restrictions on the rights of crop farmers to use and develop land for agricultural purposes during the operation of the Project (e.g. through the enforcement of safety and security restrictions along the flowline corridors) may have negative impacts upon crop farming livelihoods. Following the installation of the flowlines, crop farmers may be prohibited from using mechanised ploughing equipment and from planting deep-rooted crops directly above the flowlines, thereby limiting the types of crops that can be grown and used to generate income. Households which are solely reliant on crop farming and lack alternative sources of income may be particularly sensitive to this impact. The magnitude of this impact is **medium**.

Community safety and security

During operations, there is the potential that local community members may approach and attempt to interfere or tamper with Project infrastructure (e.g. flowlines), generating health and safety risks for local communities, the local environment and the Project workforce (e.g. maintenance workers, security personnel). The magnitude of this impact is **high**.

Other possible impacts (similar to those identified for the construction phase) are as follows:

- Tensions between non-local workers and members of the PACs, leading to conflict.
- Negative interactions between community members and Project security personnel, leading to conflict and potentially the inappropriate use of force.
- Dissatisfaction with the handling of social issues by the Project amongst PAC members, leading to an increase in the number of road blocks and other forms of protest.
- Risk to safety of local residents of Project traffic, primarily concerning tanker trucks, which will operate throughout the day.

Public health

- Transmission of new communicable diseases between the non-local and local Project workforce, leading to a reduction in health and well-being at the community level and increased pressure on local health care facilities.
- Increase in respiratory conditions or exacerbation of existing respiratory conditions resulting from a decline in local air quality.

Infrastructure and services

Potential impacts include:

- Improper handling and disposal of Project waste, leading to a deterioration in environmental conditions and potential outbreak of diseases.
- Use of local health services by contractor and sub-contractor employees, leading to negative outcomes for health care provision for the PACs.
- Blame directed towards the Project by PAC members over perceived reduction in access to water leading to loss of support for the Project.

Traffic on access roads near the Project site

Project traffic during the operations phase is expected to be significantly less than during construction and will be limited to the occasional transport of supplies to site and waste offsite. However, approximately 50 tanker truck round trips per day are anticipated for the transportation of condensate offsite. A magnitude in terms of deterioration in existing road conditions leading to vehicle damage, longer journey times and increased risk of accidents for local people is **high**. The potential for environmental impacts related to accidents that cause spills concerning the transport of fuel, condensate and other hazardous substances is addressed in the sections on soil and water resources.

Visual impacts

The magnitude of tall structures installed at the site adding to disturbance of well-being of residents of local communities is **low**.

The magnitude ranking of the impacts of operations phase lighting (whether at night or during the day), in terms of quality of life for local communities, taking into account downward facing lighting and other standard lighting approaches for reduction of impacts, is **low**.

The generation of light from flaring will be most noticeable during night-time periods. The quantity of gas flared, and the frequency of flaring incidents, will be minimised by Pearl Petroleum as flaring natural gas represents a loss of revenue and waste of the resource that Pearl Petroleum is involved in gathering and processing. The magnitude ranking for daytime flaring under non-routine events is **low**

The height of high-level flares during non-routine events (for example, shutdowns of one or both trains) will determine the distance from which they are visible. The flares will only be used for process upsets and emergencies. Under clear air conditions, a 50 m high flare would, theoretically, be visible up to 30 km from the site.

The magnitude ranking for daytime flaring under non-routine events is **low**. The magnitude ranking for night-time non-routine flaring is **medium**.

Vulnerable groups (see Section 5.7.7.1.11)

- Reduced ability of vulnerable groups to access Project-related economic benefits, leading to increased levels of vulnerability and inequality.
- Reduced ability of women to access Project-related economic benefits, leading to increased levels of gender inequality.

- Challenges to power structures and social dynamics as a result of women's employment by the Project, leading to an increase in conflict and GBV amongst households.
- Reduced ability of vulnerable groups to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits.
- Reduced ability of women to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits.

5.7.7.3.4 Summary

The significance of potential impacts related to the regional economy; land access and livelihoods; community safety and security; traffic on access roads near the Project site and visual impacts, prior to mitigation are summarised in Table 5-58, Table 5-59, Table 5-60, Table 5-61 and Table 5-62 respectively.

Table 5-58 Summary of unmitigated potential impacts on the regional economy during operations

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Contribution of the Project to the development of Kurdistan's oil and gas sector and regional economic growth	Positive	Medium	Positive	N

Table 5-59 Summary of unmitigated potential impacts on land access and livelihoods during operations

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Restriction on the rights of crop farmers to use and to develop land during the operation of the Project, leading to limitations on the types of crops grown and used to generate income	Medium	High	High	Y

Table 5-60 Summary of unmitigated potential impacts on community safety and security during operations

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Health and safety risks for local communities, the local environment and the Project workforce due to interference or tampering with Project infrastructure by community members, leading to environmental damages, injury and potential mortality	High	High	Major	Y

Table 5-61 Summary of unmitigated potential impacts on traffic during operations

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation Required (Y/N)
Interference with users of the public road network arising from temporary road closures and deviations.	High	Medium	High	Y
Deterioration of the physical condition of the public road network leading to vehicle damage, longer journey times and increased risk of accidents for local people.	High	Medium	High	Y

Table 5-62 Summary of unmitigated potential visual impacts during operations

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation Required (Y/N)
Tall structures installed at the site adding to disturbance of well-being of residents of local communities	Low	Low	Slight	N
Daytime non-routine flaring leading to disturbance of well-being of residents of local communities	Low	Medium	Minor	N
Night time non-routine flaring leading to disturbance of well-being of residents of local communities	Medium	High	High	Y
Night lighting leading to disturbance of well-being of residents of local communities	Low	Medium	Minor	Y

5.7.7.4 *Decommissioning phase*

5.7.7.4.1 Baseline context and receptor sensitivity

Pearl Petroleum is a particularly important source of formal employment in the PACs (both directly and indirectly through its contractors and sub-contractors); alternative employment opportunities are scarce.

Whilst there are several challenges pertaining to infrastructure and service provision in the PACs, Pearl Petroleum also plays an important role in providing support to local communities through various Social Investment Programmes (SIPs). These include the provision of water and power (electricity) and the upgrading of infrastructure such as schools and health care facilities. Long-term plans to support local communities include the provision of learning and medical equipment, scholarships and training courses for prospective university students and local teachers and agricultural programmes to improve the livelihoods of local farmers and livestock rearers (CPDG, 2019g).

The sensitivity of this receptor is considered to be **high**.

Otherwise receptors are the same as those highlighted in Section 5.7.7.1.

5.7.7.4.2 Project aspects

See Section 5.7.7.1.

5.7.7.4.3 Magnitude of potential impacts

The following potential socio-economic impact, identified during construction, may also occur during the decommissioning phase of the Project:

Employment and skills development

The main potential impact concerns retrenchment of workers, leading to economic shock and reduced living standards at the household level. Detailed assessment of this impact is presented in Section 5.7.7.1.2. This impact, however, is expected to be less significant during decommissioning compared to construction, owing to the fact that fewer employment contracts will be terminated at this stage.

Infrastructure and services

The main potential impact concerns closure and eventual decommissioning of the Project. The closure of the Project has the potential to lead to a deterioration in living standards and well-being where PACs become dependent on the support and services provided by Pearl Petroleum during its lifetime. PAC members may experience difficulties in sustaining access to power and water, for example, if they become dependent on Pearl Petroleum and suitable alternatives are not found. The scope of this impact assessment is only on the Project, rather than the existing facility as a whole. The magnitude of this impact is **high**.

Traffic impacts during the decommissioning phase will be similar to those experienced during the construction phase of the Project (see Section 5.7.7.1.9).

5.7.7.4.4 Summary

The significance of potential impacts prior to mitigation are summarised in Table 5-63.

Table 5-63 Summary of unmitigated potential impacts on infrastructure and services during decommissioning

Impact	Magnitude	Sensitivity	Unmitigated impact significance	Mitigation required (Y/N)
Deterioration in PAC living standards and well-being if the PACs become dependent on Pearl Petroleum and related economic opportunities, support and services are withdrawn.	High	High	Major	Y

5.8 Cumulative impacts

Possible cumulative impacts for the KM250A Project in relation to other development activities within the various AOIs for the KM250A Project relate to future expansion at the Khor Mor site. Although details regarding the potential configuration (and thus impacts) of future expansion projects are not currently known, the likely adverse impacts are as follows:

- Increased air emissions (similar to those released through the various phases of the KM250A Project).
- Increased groundwater consumption, leading to possible depletion of the local aquifer, on which both Pearl Petroleum and local residents rely.
- Increased local traffic resulting in increased risk to local populations and increased pressure on local roads (especially during the construction and operations phases of future projects).
- Increased pressure on Pearl Petroleum Khor Mor waste management facilities (especially on-site hazardous waste storage facilities and offsite non-hazardous waste management/disposal facilities).
- Additional pressure on habitat and biodiversity via installation of additional flowlines.

Positive impacts would include a solution to retrenchment (as construction workers could be recruited for future projects), and increased use of local goods and services (including labour).

5.9 Ecosystems services

Key findings on the impacts of ecosystem services (ES) in the Project AOIs are summarised in Table 5-64.

Table 5-64 Summary of possible KM250A Project ecosystems and impacts

Type of ES	Relevant to the Project?	Does the Project have direct management, control or significant influence on the ES?	Is the Project likely to have an impact or result in adverse impacts on PACs?	Does the Project depend upon this ES for its operations?	Type of ES (1 or 2)	Priority ES?
Provisioning service - land	Yes	Yes – the Project will require land take for the construction of up to five additional flowlines and new well pads (with corresponding safety zones) external to the boundary of the existing facility during construction.	Yes – land is a vital ecosystem service in PACs, providing the fundamental resources (e.g. soil, water, pasture, cultivars) on which local livelihood activities such as crop farming and livestock rearing depend. In the absence of land, household income and food security, and therefore health and well-being, would be severely affected.	No – whilst the Project will need continued access to the land acquired during construction for maintenance purposes, no additional land take will be required by the Project during operations.	1	Yes
Provisioning service – freshwater (including groundwater and/or surface water)	Yes	Yes – the Project will require water for various activities during the construction phase (e.g. dust suppression, compaction) as well for direct consumption by the construction workforce. Water will be further required during pre-commissioning/commissioning for hydrotesting.	Yes – freshwater is a vital ecosystem service in the PACs. Local livelihood activities, particularly livestock rearing, depend on this resource. Freshwater is also relied upon for direct human consumption, domestic purposes and (to a lesser extent) to irrigate crops. In the absence of freshwater, household income, health and well-being would be severely affected.	Yes – during operations, the Project will rely on water for processing purposes, for direct consumption by the operations workforce and during non-routine events (e.g. fire outbreaks).	1/2	Yes
Provisioning service – construction materials	Yes	Yes – the Project will require aggregates (e.g. gravel) and other materials during the construction phase.	No – some households gather local aggregates (e.g. stone), wood, mud and other materials in the AOI for construction purposes. Whilst these resources benefit households by helping to provide shelter for household	No – construction aggregates will not be required by the Project during operations.	--	-

Type of ES	Relevant to the Project?	Does the Project have direct management, control or significant influence on the ES?	Is the Project likely to have an impact or result in adverse impacts on PACs?	Does the Project depend upon this ES for its operations?	Type of ES (1 or 2)	Priority ES?
			members, the baseline data indicates that households do not rely solely on those which are locally available (supplies from further afield/outside the AOI are also relied upon).			

* **Type 1** ES are those most likely to be impacted significantly by Project operations and may therefore result in direct adverse impacts to PACs' livelihood, health, safety and/or cultural heritage. **Type 2** ES are those on which the Project directly depends upon for its primary operations.

5.10 Impact assessment for unplanned activities

5.10.1 Impact assessment for unplanned activities

As mentioned earlier, an unplanned event is defined as a reasonably foreseeable event that is not planned to occur as part of the project, but which may conceivably occur as a result of project activities (for example accidents) with a low likelihood of occurrence. Unplanned events leading to environmental or social impacts are assessed in the sections below.

Reference is made to various studies undertaken for the KM500 expansion (of which the KM250A Project is Phase 1), especially the Hazard Identification study (HAZID, Hatch 2019j), the Central Processing Facility Fire & Dispersion Hazard Analysis, (FDHA, Hatch 2018) and the Hazard and Operability study (HAZOP, Hatch 2019k). The aim of these studies was to identify hazards from KM500 operations and assess the on-site, rather than offsite, impacts.

Further details are presented in the following sections.

5.10.2 Hazard Identification study

The objectives of the HAZID were to:

- identify major accident events associated with operation of the facilities
- evaluate the impacts for each identified hazard
- allow an interdisciplinary review of the existing operations, where information is available
- recommend potential risk reduction measures to design out the hazards and/or environmental impacts, or if this is not possible, introduce engineering or operating measures to prevent or control the risks or specify appropriate mitigating measures to minimize the effects.

5.10.2.1 Methodology

A meeting of a group of experts was convened for implementation of the HAZID. The purpose of the workshop was to identify hazards. Solutions were proposed in terms of actions; actions were evaluated during action close-out.

The following steps were adopted for the HAZID:

- Distinct areas of activity with the potential to give rise to hazardous conditions within the defined KM500 scope were identified.
- Guidewords were used as prompts to identify hazards.
  - The potential safety consequences of each hazard were recorded on worksheets along with existing or planned safeguards that eliminate, prevent, detect, control or mitigate the hazard. During the meeting worksheets were projected onto a screen so all attendees could see and review entries as they were made.
  - The identified hazards were ranked according to risk, taking into account the identified safeguards.
  - Actions were raised if additional measures were required to adequately mitigate a hazard.

- Each recommendation was assigned to Pearl Petroleum or an appropriate Hatch discipline to complete.

5.10.2.2 Summary of results

The HAZID resulted in identification of the following major hazards:

- earthquake (see Section 3.2.2.3)
- lightning strike
- subsidence
- security threat from local community
- terrorist attack on plant
- unexploded ordinance
- construction activities over existing flowline/ pipelines
- loss of containment from in-boundary wells
- loss of containment due to hydrogen sulphide (H_2S) or carbon dioxide corrosion
- loss of containment due to external corrosion
- fire in chemical storage areas
- human error due to inexperience with operating new plant
- inadequate emergency plan (for new plant hazards)
- loss of containment due to poor integration of control systems
- adverse interactions between simultaneous operations (SIMOPs) during the construction and operations phases, including:
  - physical impact by construction activities, e.g. vehicles, dropped objects
  - loss of containment from the operating plant
  - ignition sources related to construction activities
  - increased manning
- emergency shut down (ESD) failure due to poor integration of systems
- electrocution due to new medium voltage supply.

5.10.3 Facility Fire & Dispersion Hazard Analysis

The objective of the FDHA was to identify representative accidental process release failure cases for the proposed KM500 facilities and carry out sufficient consequence modelling to provide input into the CPF equipment layout and spacing.

5.10.3.1 Methodology

The following approach was adopted for the FDHA:

- failure case identification and definition
- consequence modelling to determine hazard over a range of hazard consequences
- risk assessment, including identification of the generic hazard, determination of causes, specific assessment of the consequences for each scenario (hole size for each failure case), and prevention and mitigation controls for each failure case

- ranking failure cases according to risk
- development of recommendations where considered appropriate to reduce risk

Potential releases from existing Khor Mor facilities were not considered.

The main hazard consequences considered in this analysis are summarised below:

- flammable gas cloud - An unignited leak from the process equipment of vapour or flashing liquid: There is no direct harmful impact of a flammable gas cloud on personnel but there is the potential for ignition to result in a flash fire.
- jet flame - Immediate ignition of a pressurized flammable gas or flashing/atomised liquid leak will result in a jet flame: Jet flame impact and exposure to high thermal radiation levels from the flame are fatal to personnel.
- flash fire - Delayed ignition of a gas cloud in an unconfined, low congestion and/or low reactivity material will result in a flash fire: Personnel within a flash fire are generally assumed to be fatalities and there is no impact on personnel outside of the fire. Equipment is not typically considered to be damaged by a flash fire.
- explosion - Delayed ignition of a flammable gas cloud of reactive material or within a confined or congested area may result in a vapour cloud explosion, with an overpressure generated outside of the gas cloud boundary: Personnel within the ignited gas cloud are expected to be fatalities. Harm to personnel from explosion blast effects outside of the gas cloud can occur at lower overpressures as a result of impact with objects, with higher overpressures being required for the blast wave to cause direct internal injury. Equipment and building damage can result from explosion overpressure. Equipment failure would lead to process escalation.
- pool fire - Ignition of a flammable liquid pool will result in a pool fire: In addition to the flame impingement and thermal radiation hazard from pool fires, significant quantities of smoke are generated, which can adversely impact personnel due to reduced visibility and/or the impact of smoke inhalation.
- toxic gas cloud - An unignited release of fluid containing H_2S will generate a toxic gas cloud, which may also be flammable depending on the composition of the released material: Unignited toxic gas clouds can pose a significant threat to personnel.

5.10.3.2 Summary of results

The FDHA presents hazard ranges for accidental process releases from the proposed KM500 facilities. Failure cases were assessed for 19 isolatable process sections; three hole sizes were modelled for each identified failure case.

The main contributors to the flammable hazards from KM500 facilities were: inlet separation, gas dehydration, liquified petroleum gas recovery and condensate export. Most results anticipated that direct impacts for the various flammable scenarios would concern the immediate process area or, at worst, neighbouring process areas. No offsite thermal radiation impacts were anticipated.

The potential for a toxic gas cloud (H_2S concentration of 5 to 10 parts per million, ppm) that would extend beyond the fenceline was identified for a large leak from the amine regeneration unit. Assessment of the potential offsite impact of this event was outside of the FDHA scope.

The FDHA risk ranking focussed on on-site impacts. No 'critical' scenarios were identified; this was attributed to the separation distance between plot areas and a low manning level on the site with respect to operations.

Various preventive and mitigating controls, in relation to ensuring the safety of plant personnel, were identified in the risk assessment. These included the following:

- preventative maintenance
- facilities upstream of gas desulphurisation (amine unit) designed to meet National Association of Corrosion Engineers (NACE) standards[26]
- emergency response plan
- flammable gas detection
- toxic gas detection
- fire detection
- ESD and blowdown
- ,minimal manning in process areas of plant
- restriction/control of lifts over pressurised equipment
- ignition controls
- plant layout (to ensure adequate separation between sources of risk and other process units, as determined by the modelling that showed minimum impact distance).

5.10.4 Hazard and Operability study

The objective of the HAZOP was to identify and qualitatively assess potential process safety and operability issues associated with operation of the KM500 facilities and to identify any gaps in management of these issues. Recommendations were raised to design out any gaps in the management of hazardous scenarios identified, but where that was not possible, additional engineering preventative and/or mitigating measures were recommended to reduce the risk.

5.10.4.1 Methodology

The HAZOP technique is a means of systematically reviewing a process, as designed, to identify potential hazardous events and operability problems. The HAZOP was conducted using engineering line diagrams and was at a coarse level only, with a more detailed HAZOP to be completed at later stages of the design.

The study was carried out by a multi-disciplinary team of individuals led by an independent chair using a set of guidewords to ensure thoroughness and a structured approach to the study. Guidewords were combined with process parameters to develop deviations from the designed operating conditions. Where safety or operability issues were identified, actions were raised to ensure the issue was addressed.

The HAZOP considered deviations from routine operating modes of the process plant, including start-up, operation, and shutdown, in order to identify hazards and safeguards that must be put in place.

[26] Equipment and piping are designed for H_2S (sour) service. NACE material requirements for H_2S service ensure resistance to sulphide stress cracking for petroleum production, drilling, gathering / flowline equipment and processing facilities to be used in H_2S-bearing hydrocarbon service.

5.10.4.2 Summary of results

The key HAZOP findings related to the following process control issues:

- response time of high high-pressure trip on inlet gas separator and test separator
- overpressure of inlet gas separator and test separator on common mode failure of choke valve pressure control
- loss of amine leading to stress corrosion cracking
- low temperature embrittlement of high pressure (HP) and low pressure (LP) cold separator piping to de-ethaniser column
- design criteria for condensate stabiliser
- HP/LP flare interface upstream of the sales gas compressor inlet scrubber
- local collection of liquids at the sales gas booster compressor package
- overfill of condensate storage tanks
- overpressure of new condensate tanker loading.

5.10.5 General conclusions

The potential offsite impacts from unplanned events on the KM500 facility, based on the HAZID, FDHA and HAZOP, is presented in Table 5-65. As mentioned above, these studies did not assess offsite impacts, however it is possible to identify potential offsite impacts based on the nature of the events. The main hazardous consequence that could affect offsite sensitive receptors is the toxic gas cloud and smoke from pool fires.

Although not covered by the above studies, within the framework of this ESIA flaring is a planned non-routine activity; the possible offsite impacts are discussed in Section 5.7.1.3 (air quality) Section 5.7.4.3 (noise) and Section 5.7.7.1.10 (visual).

Table 5-65 Potential offsite impacts for unplanned events

Event	Source	Potential offsite impact	Environmental impact	Description
Hydrocarbon pool fire	HAZID and FDHA	Smoke	Air quality Socio-economic	Potential for short-term deterioration of ambient air quality at sensitive receptors Short-term impact of disturbance of well-being of residents of PACs within primary sphere of influence (see Figure 3-16)
		Firewater run-off	Soil Water resources Biological environment	Contaminated spent firewater could pollute surface soil, surface water and water resources (see Sections 5.7.2 and 5.7.3 for similar impacts in the case of planned activity non-routine events, especially concerning spills). Polluted water or soil could

Event	Source	Potential offsite impact	Environmental impact	Description
				lead to injury/mortality of aquatic or terrestrial flora and fauna. It is expected that fire water will be contained in the site drains, thus avoiding any offsite impacts.
Process gas release	FDHA	Toxic gas	Biological environment Socio-economic	Potential for an on-site process gas release from the amine regeneration unit resulting in H_2S levels of 5 - 10 ppm offsite. This may result in harm to aquatic or terrestrial flora or fauna and/or an odour impact for residents of nearby communities. Further assessment is required to determine the expected elevation of these gas clouds at sensitive receptors and potential ground level concentrations of H_2S.
Major process release Major process upset	HAZID, FDHA & HAZOP	Cessation of services	Socio-economic	Plant shutdown is a possible response to a major unplanned process release. This may result in cessation of services provided by Pearl Petroleum to local communities, with consequent loss of benefits (especially employment), either short-term or long-term.

5.11 Associated facilities

As described in Section 2.10, five production wells will be developed in association with the KM250A Project. A comprehensive separate detailed ESIA will be developed for these facilities. A high-level summary of expected potential impacts of these facilities is provided in Table 5-66. This analysis has been developed based on baseline information collected for this (KM250A Project) ESIA, on the existing ESIA undertaken for wells KM9, KM10 and KM12 (MapCom 2018), and on RSK experience with onshore oil and gas drilling.

To facilitate the identification of potential impacts, the following AOIs were considered:

- the well site footprint (access road, drilling location, rig camp)
- the zone of visual impact, including the zone that experiences artificial lighting coming from the well site
- the area within which dust may settle (approximately 100 m radius from the well site)

- the area in which air quality may be degraded as a result of a well test (extending approximately 8 km downwind of the well flare)
- the area in which air quality may be degraded as a result of routine emissions during exploration drilling (this involves small mobile sources that are not suitable for mathematical modelling, so the area is not defined, but in practice will be local to the equipment and temporary while the equipment is running)
- the area within which noise may be audible (generally limited to the well site)
- the areas into which grazing herds may be displaced if they would otherwise have grazed over the well site footprint (this is difficult to define as herds move regularly anyway in search of grazing areas)
- the road network where construction traffic may result in a noticeable increase in traffic levels
- the area that could be affected by accidental contamination of groundwater or hazardous materials spill that cannot be contained at the well site.

Catastrophic events may also occur during drilling. For example, if ‘kill weight’ mud cannot be circulated through the well in time, a ‘blowout’ may ensue. Gas may escape freely from the well into the environment, until the pressure is relieved, or the well is brought back under control. The well casing may collapse and cut off the pathway by which the hydrocarbons can escape to the surface, or engineers may regain control of the hydrocarbon flow by capping the well or by drilling a relief well. When an uncontrolled release of gas from the wellbore comes into contact with a source of ignition, the resulting explosion and fire can result in damage to the rig and its fuel storage tanks.

Blow out prevention and other precautionary measures that will be built into the design of the equipment and into drilling procedures significantly reduce the probability of a blowout. Furthermore, the Pearl Petroleum Emergency Response Plan covers such events in the case that a blowout cannot be prevented. Further details with respect to blowouts or other possible unplanned events will be provided in the HAZID/HAZOP that will be undertaken for the production wells.

Table 5-66 Potential impacts for associated facilities (five production wells)

Area of concern	Project aspect	Potential impact
Air Quality	Site preparation and levelling (mobilisation) and return of site to its original conditions following well completion (demobilisation) and vehicle traffic on unpaved roads.	Dust (particulate matter) can arise at the site and on unpaved roads. In this arid region groundwork during construction and the movement of heavy vehicles on gravel roads or unpaved can raise dust. Exposure to increased levels of dust can affect the health of local people and exacerbate respiratory illnesses. Generally, dust particles settle on the ground within approximately 100 m, so outside of villages dust is not likely to be a significant impact. Dust raised within villages by passing traffic to be controlled by measures like those adopted within this ESIA.
	Operation of construction equipment (including generators and vehicles and other moving equipment	Emissions from diesel generators, vehicles and other equipment, including CO, CO_2, NOx, SO_2, H_2S, VOCs and particulate matter. Emissions are not likely to have an impact on PACs.
	Operation of drilling equipment (including drilling machinery and compressors)	
	Flaring during drilling	Possibly high ground level concentrations of NOx and SO_2 at PACs.
Noise	Operation of construction equipment (including generators, vehicles and other moving or stationary equipment	The production wells will be in remote locations, such that human receptors are unlikely to be present, unless individuals (including herders) pass through the site. Noise and vibration may cause temporary displacement of species from breeding and foraging habitat. This will be of relatively short duration.
	Operation of drilling equipment (including drilling machinery and compressors)	
	Flaring during drilling	

Area of concern	Project aspect	Potential impact
Water Resources and Soil	Accidental releases from fuel storage tanks	Fuel storage tanks at the well sites will include spill containment measures, thus limiting possible leaks or spills to soil and subsequent leaching to groundwater.
	Accidental releases of drilling and related fluids	This could result in contamination of soil and groundwater. However, the use of water-based muds significantly reducing the possibility of harmful effects.
	Drilling the production wells could provide a conduit for water from saline aquifers to mix with the fresh groundwater.	Deep groundwater flows are most likely protected by overlying, less permeable strata. While the well is being drilled it will be filled with drilling mud that has a density sufficient to balance the groundwater pressure. The purpose of this is to prevent groundwater from entering the well, where it could affect the ability of the drilling mud to remove cuttings from the well. The upper sections of the well will be drilled in a few days, and then a casing will be installed. Once the casing has been cemented (during completion) the well will be isolated from groundwater flows, and the aquifers will be isolated from each other.
	Leaching from reserve pits	Reserve pits will be lined, thus reducing the possibility of harmful effects.
	Loss of vegetative cover	This could result in erosion and changes in natural drainage patterns.
	Worker sanitary facilities	Sanitary wastes will be collected and managed offsite.
	Transport of diesel fuel by tanker truck	The capacity of a road tanker (c. 30-40 m^3) defines an upper limit for a diesel release away from the site. However, away from the rig site, there will not be secondary containment of the spill.
Biodiversity	Removal of vegetation within Project footprint (including the access road)	Breeding and foraging habitat loss and/or fragmentation for small mammals and avifauna.

Area of concern	Project aspect	Potential impact
	Waste pits	Discharge and storage of drilling waste in water pits has the potential to affect birds and animals that are attracted to the water and either drown (because they cannot climb up the sides of the pit) or become contaminated with oil. Migrant birds may be particularly at risk along with predatory birds, of which there are some threatened species in the Project area.
	Accidental releases of fuel or drilling related fluids	Potential contamination of food and water sources used by fauna
	Flaring	Noise and light disturbance causing temporary displacement of fauna from breeding and forage habitat
Socio-economic – local economy	Procurement of goods and services	Opportunities for local and regional businesses to supply goods and services, generating multiplier effects across the local economy.
Socio-economic – employment and skills development	Recruitment of workforce	In-migration, leading to increased competition for land, housing and basic services. Employment opportunities, leading to an improvement in household living standards and well-being. Training opportunities, leading to improved OHS awareness and the enhancement of future employment prospects. Unmet expectations, leading to dissatisfaction and loss of support for the production wells amongst PACs. Tensions between those who benefit economically and those who do not, leading to conflict. Retrenchment of workers, leading to economic shock and reduced living standards at the household level.

Area of concern	Project aspect	Potential impact
Socio-economic – labour and working conditions	Use of contractors and sub-contractors	Labour rights violations in the supply chain, leading to negative impacts on workers' health and well-being. Failure to meet international OHS standards by contractors and sub-contractors, leading to increased risk of workplace accidents.
Socio-economic – land access and livelihoods	Acquisition of land for well sites	Loss of access to land used for crop farming, livestock rearing and natural resource harvesting, leading to decreased income, food security and living standards. Exacerbation of existing conflicts and/or new generation of new conflicts during the land acquisition and compensation process, leading to loss of support by PACs.
Socio-economic – community safety and security	Transportation of process equipment, drill pipe and other materials by road Workforce commuting to/from site during all phases (mobilisation, drilling and demobilisation)	Increased volume of traffic, leading to increased noise and an increased risk of road traffic accidents involving community members and livestock.
	Site security	Negative interactions between community members and security personnel, leading to conflict and potentially the inappropriate use of force.
	Flaring	Anxiety, irritation and a reduction in overall well-being amongst the PACs resulting from the noise and light generated by gas flaring.
Socio-economic – infrastructure and services	Transportation of process equipment, drill pipe and other materials by road Workforce commuting to/from site during all phases (mobilisation, drilling and demobilisation)	Deterioration in existing road conditions, leading to vehicle damage, longer journey times and increased risk of accidents for local people.

Area of concern	Project aspect	Potential impact
	Mobilisation and drilling activities	Blame directed towards the production wells by PAC members over perceived reduction in access to water, leading to loss of support amongst PACs.
Socio-economic – cultural heritage	Mobilisation and drilling activities	Risk for cultural heritage artefacts or other evidence.
Socio-economic – vulnerable groups	Recruitment of workforce	Reduced ability of vulnerable groups and women to access economic benefits, leading to increased levels of vulnerability and inequality.
	Acquisition of land for well sites	Reduced ability of vulnerable groups to effectively engage and participate in the land acquisition and compensation process, leading to discrimination and increased inequality.
	Mobilisation and drilling activities	Reduced ability of vulnerable groups and women to access information, leading to lower levels of awareness about the production wells and the potential associated benefits.

6 MITIGATION MEASURES

This section only considers the application of mitigation measures for impacts identified as significant (i.e. impacts that have a significance rating of moderate or higher) and not for impacts identified as insignificant (i.e. impacts which are minor or slight). However, in some cases, measures are suggested that will further reduce impacts that are already rated insignificant (this is in keeping with good international industry practice). Phases for which mitigation measures are not necessary have not been included.

Some mitigation measures apply to more than one impact.

A construction phase environmental and social management plan, designated by Pearl Petroleum as the Health, Safety, Security (HSSE) & Social Performance (SP) Management Plan (HSSE&SP MP), will be developed by Pearl Petroleum within the framework of the Pearl Petroleum HSSE&SP Management System (MS) for the KM250A Project (see Section 10). The engineering, procurement and construction (EPC) Contractor will develop an HSSE&SP MP for the KM250A Project within the framework of the construction phase based on the Pearl Petroleum construction phase HSSE&SP MP. Pearl Petroleum will also develop HSSE&SP MPs for subsequent stages of the Project (that is, operations and decommissioning). Implementation of the mitigation measures highlighted in this section will follow the corresponding HSSE&SP MPs.

Opportunities to maximise positive impacts have also been identified in this section.

6.1 Air quality

6.1.1 Construction phase

Air quality impacts during the construction phase of the Project were all rated insignificant. Nonetheless, various measures are provided below that will further reduce impacts:

- EPC Contractors will develop and implement vehicle maintenance program and equipment maintenance programs (e.g. power generators, construction equipment).
- EPC Contractors will develop and implement a Dust Management Plan allowing for dust suppression by spraying water onto dirt tracks and flowline RoWs:

6.1.2 Operations phase

The atmospheric air dispersion modeling study (ADMS) has shown that maximum offsite concentrations from the Project during routine or non-routine operations will cause an exceedance of the Project Standards for nitrogen dioxide (NO_2, 1-hour averaging period) and sulphur dioxide (SO_2 ,1-, 3- and 24-hour averaging periods), resulting in high significance ratings.

Pearl Petroleum is committed to meeting the KM250A Project Standard for SO2 and NO2 emissions. Furthermore, the EPC Contractor is contractually obliged to meet the Project Standards. Taking guidance from the World Health Organisation ambient air quality guidelines (adopted by IFC, 2007), Pearl Petroleum will take a stepped-approach to meet the interim targets and guideline values, closely monitoring and reviewing the design deliverables to ensure compliance, with a focus on the thermal oxidiser. At the 95th percentile, operations will comply with the WHO/IFC interim target 1, which is equivalent to the KRG standard (Appendix 3, Table A3-6).

In the case of NO_2, the exceedance can be attributed to the combined effects of all point sources operating at the same time. Further evaluation during the detailed engineering phase including re-run of air quality model with detailed design specifications to confirm compliance with the Project Standards (ENV01). Pearl Petroleum is confident that this stepped- approach will result in compliance with the Project Standards.

In the case of SO_2, the exceedance is almost entirely caused by emissions from the thermal oxidiser. The elevated SO_2 concentrations in the exit flue gas is due to high hydrogen sulphide (H_2S) in the acid gas feed to the unit (from the amine treatment unit). A sulphur recovery unit (SRU) is planned for the future for the acid gas stream (this the SRU will remove sulphur from the acid gas and convert it to elemental sulphur). Further evaluation of compliance solutions (such as a sulphur recovery unit, flue gas scrubbers, thermal oxidiser design specifications, caustic wash) will be undertaken during the detailed engineering phase (ENV02). The air quality model will be re-run with detailed design specifications to confirm compliance with the Project Standards (ENV01). Pearl Petroleum is confident that this stepped-approach will result in compliance with the Project Standards.

A summary of the operations phase mitigation measures and residual impacts for air quality is presented in Table 6-1. **These mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below 'significant'.**

Table 6-1 Summary of operations phase mitigation measures and residual impacts - air quality

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Emissions from routine or non-routine operations of the gas plant leading to increase in NO_2 ambient ground level concentrations	High	ENV01	Minor
Emissions from routine or non-routine operations of the gas plant leading to Increase in SO_2 levels in ambient air	High	ENV01 ENV02	Minor

6.2 Soil

Impacts on soil during the construction phase of the Project were all rated insignificant (minor or below) so no mitigation measures are required.

6.3 Water resources

6.3.1 Construction phase

Groundwater abstraction is likely to cause impacts without the necessary mitigation measures that will ensure the protection of groundwater. In addition, potential impacts on groundwater quality due to the storage of fuels and chemicals will also require mitigation to reduce the significance to acceptable levels of minor or less.

The measures recommended to mitigate potential impacts from abstraction are as follows;

- Pearl Petroleum Health Safety and Environment (HSE) department will undertake a quantitative impact assessment to evaluate the drawdown impact on local water users (ENV03). If an impact is likely then relocate the proposed location of the camp abstraction borehole(s) to a location where no impact will occur.

  A Water Management Plan will be developed (ENV04) with the aim of ensuring that water resources used in the KM250A Project during the construction and commissioning phases are used in an environmentally and socially sustainable way, and that any potential negative impacts that may occur as a result of the KM250A Project are prevented or, if this is not possible, are as low as reasonably practicable (ALARP).
- An abstraction permit will be obtained from local authorities (ENV05).

These measures will reduce the residual significance of this impact to **minor**.

The measures recommended to mitigate potential impacts from the storage of fuels and chemicals are as follows:

- Refuelling will be undertaken at designated areas according to industry guidelines (ENV06).
- Chemicals and hydrocarbons will be stored within secondary containment and according to industry guidelines (ENV07).

The measures will reduce the residual significance of this impact to **minor**.

A summary of the construction phase mitigation measures and residual impacts for groundwater is presented in Table 6-2. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-2 Summary of construction phase mitigation measures and residual impacts – water resources

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Groundwater abstraction leading to aquifer drawdown	High	ENV03 ENV04 ENV06	Minor
Storage and handling of fuels and chemicals leading to leaks/spills and reduced groundwater quality	Moderate	ENV06 ENV07	Minor

6.3.2 Pre-commissioning and commissioning phase

To avoid excessive drawdown of local water resources during hydrotesting and to avoid leaks and spills leading to reduced groundwater quality, Pearl Petroleum will apply the same measures developed for the construction phase (see Table 6-2).

6.3.3 Operations phase

To avoid leaks and spills leading to reduced groundwater quality, Pearl Petroleum will apply the same measures developed for the construction phase (see Table 6-2).

6.3.4 Decommissioning

To avoid leaks and spills leading to reduced groundwater quality, Pearl Petroleum will apply the same measures developed for the construction phase (see Table 6-2).

6.4 Noise

During the construction phase of the KM250A Project there is potential for significant adverse impacts if construction works are undertaken (exceptionally) during the night. At this stage, the detailed methodology for the construction works has not been defined and consequently specific mitigation measures cannot be given.

Standard best practice control measures shall be adopted on-site to ensure that noise management forms an integral part of the contractors' scope of works.

The following mitigation measures are proposed to limit the potential for noise impacts at surrounding receptors in the event that night-time working is deemed necessary:

- Adopt quiet working methods, where reasonably practicable, using plant with lower noise and vibration emissions (ENV08).
- Avoid or limit noisy construction activities during the night-time period (ENV09)
- Use acoustic screens and/or enclosures for static items of plant which generate noise levels that have the potential to cause disturbance (ENV010).
- Carry out regular inspections of noise mitigation measures to ensure integrity is maintained at all times (ENV011).
- Provide briefings for all site-based personnel so that noise issues are understood, and mitigation measures are adhered to (ENV012).

It is considered that with the implementation of a series of mitigation measures, together with careful planning and sequencing of the works, the likely night-time noise impacts during the construction phase of the works can be managed to achieve appropriate levels at the surrounding sensitive receptors.

Following the introduction of an appropriate scheme of mitigation, the construction activities associated with the proposed development are predicted to constitute a medium-term, **minor** adverse impact.

A summary of the construction phase mitigation measures and residual impacts for noise is presented in Table 6-3. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-3 Summary of construction phase mitigation measures and residual impacts - noise

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Construction activities – night-time leading to potential increases in ambient noise	Major	ENV08 ENV09 ENV10 ENV11 ENV12	Minor

6.5 Biological environment

6.5.1 Construction phase

6.5.1.1 Habitats

This document will set out ways in which potential impacts on sensitive habitats will be reduced and will include the following:

- Limit vegetation removal to the extent required for construction activities, including storage and laydown areas, and safety requirements.
- Limit driving to designated routes on existing roads, where possible.
- Areas identified as potential natural habitat in the impact assessment sections will be avoided, where possible.
- Restore natural habitats on pipeline route and storage areas after construction activities are complete including returning the segregated topsoil to the site and reseeding or replanting areas with native species. To be developed through the production of a Bio-restoration Plan which will form part of the construction phase contractor HSSE&SP MP.
- Develop a Biodiversity Management Plan (to include bio-security and bio-restoration) (ENV13) which will form part of the construction phase contractor HSSE&SP MP and will incorporate the following considerations:
    - any ecology restoration will utilise native plant species

- all equipment/machinery will be sourced locally to avoid the spread of invasive species.
- Contractor will implement erosion and sediment control measures.
- Contractor will implement soil conservation measures.

6.5.1.2 Flora

Mitigation is required to retain the population of important plant species if present within natural habitats. To mitigate the potential impacts of development, the following measures will be implemented:

- Undertake a preconstruction survey for important plant species in areas identified as potential habitat in particular along flowlines where routes are likely to be re-surveyed (ENV14).
- Evaluate practical alternatives to avoid or reduce impacts to the important plant species if these species are identified within areas subject to land disturbing activities (ENV15).
- Prohibit the collection of natural resources, such as plant materials for firewood, food or medicine (ENV16).
- Use appropriate technique (seed harvesting/cutting/translocation) to move individual plants from the construction footprint if the individual cannot be avoided during land disturbing activities (ENV17).

6.5.1.3 Fauna

The following measures will be used to reduce impacts on fauna during the construction phase:

- Undertake site clearance with due consideration to main breeding season (ENV18).
- Conduct preconstruction surveys to identify any active burrows or nests of sensitive species (see above).
- Establish a 10 m buffer zone, if possible and practical, around the burrow or nest where no construction may occur until monitoring indicates that the species has left the nest/burrow. if sensitive species active nests or burrows are found within areas subject to land disturbance (ENV19).
- Evaluate alternatives to relocate the species, if sensitive species active nest or burrow cannot be avoided; and seek approval from regulator (ENV20).
- Prohibit deliberate disturbance or killing of fauna by site workers - any unintentional killing or injury of species to be reported and tracked internally. If required adaptive management may be used to reduce unanticipated impact on animals (ENV21).
- Limit vegetation removal to the extent possible (ENV22).
- Consider animal bypass around flowline construction zones, as deemed necessary (ENV23).
- Restore habitats in temporary workspaces after construction activities are complete including returning the segregated topsoil to the site and restore ecology with native species (ENV24).
- Reduce the time between construction and reinstatement for works undertaken in sensitive habitats to the extent possible (ENV25).

- Contractor to ensure that contractor Waste Management Plan provides for avoidance of waste storage or other waste management procedures that reduce potential forage by nuisance species (ENV26).
- Undertake toolbox talks with staff to educate them on what species are likely to be present on-site and on correct actions to be taken if any animals are encountered (ENV27).

The contractor HSSE&SP MP will also incorporate waste management, pollution control and air quality/dust control measures that will also reduce potential impacts on ecology and biological environment.

The impact of noise and visual disturbance affecting birds and mammals is considered moderate. This impact can be mitigated by restricting or limiting such activities in sensitive areas to daytime hours only to the extent possible.

The possible introduction of alien invasive species out-competing native species is considered low risk (that is, insignificant), nevertheless the chances of this occurring can be further reduced by the following measures:

- source construction materials and equipment from in-country, to avoid transportation of foreign species to the region
- contractor to develop a biosecurity plan that incorporates the following considerations
- utilise native plant species in any ecology restoration.

The risk of contamination of fauna food and water supply from human waste is considered moderate. This risk can be reduced by ensuring that the EPC Contractor meets effluent quality criteria established by Pearl Petroleum with respect to any wastewater discharges.

6.5.1.4 Summary

A summary of construction phase mitigation measures and residual impacts is presented in Table 6-4. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-4 Summary of construction phase mitigation measures and residual impacts – ecology and biodiversity

<table>
<tr><th>Poential impact</th><th>Unmitigated impact significance</th><th>Mitigation measures</th><th>Residual impact significance</th></tr>
<tr><td>Development of Project footprint leading to potential direct permanent loss of ecologically significant habitat and vegetation</td><td>Moderate</td><td rowspan="3">ENV13
ENV14
ENV15
ENV16
ENV17
ENV18
ENV19
ENV20
ENV21
ENV22</td><td>Minor</td></tr>
<tr><td>Development of Project footprint (for areas to be restored after construction such as storage areas, construction camp, flowlines) leading to potential direct temporary loss of ecologically significant terrestrial habitat and vegetation within flowline RoW and other temporary facilities.</td><td>Moderate</td><td>Minor</td></tr>
<tr><td>Various construction activities leading to permanent loss and fragmentation of breeding and foraging habitat (fauna)</td><td>Moderate</td><td>Minor</td></tr>
</table>

Poential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Site preparation leading to soil erosion or compaction resulting in poor re-establishment of vegetation	Moderate	ENV23 ENV24 ENV25 ENV27	Minor
Various construction activities and human activities leading to noise and disturbance to fauna	Moderate		Minor
Various construction activities leading to disturbance, loss of prey availability and potential accidental mortality to foraging and nesting birds	Moderate		Minor Minor
Site clearance works leading to direct mortality of species from collisions with equipment and vehicles	Moderate		Minor
Inadvertent chemical spills leading to habitat loss and injury/mortality of flora and fauna from food and surface water contamination	Moderate	ENV26	Minor

6.5.2 Pre-commissioning and commissioning phase

There are no additional mitigation measures beyond those proposed for the construction and operations phase (See Section 6.5.3).

6.5.3 Operations phase

During the operations phase the following mitigation measures will be utilised to reduce potential operational impacts on fauna and fauna:

- develop and implement vehicle maintenance program to manage gaseous emissions from vehicles (see Section 6.1.2)
- utilise the preconstruction survey conducted to delineate sensitive habitats and restrict access to these areas (see Section 6.5.1)
- limit driving to designated routes (see Section 6.5.1)
- design permanent truck route to avoid sensitive habitats (see Section 6.5.1)
- limit office operations to daylight hours, where possible (ENV28)
- develop and implement a Lighting Plan for the new and existing facilities to limit spread by using directional lighting, hoods, etc. and only light the working areas (ENV29).

A summary of operations phase mitigation measures and residual impacts is presented in Table 6-5. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-5 Summary of operations phase mitigation measures and residual impacts – ecology and biodiversity

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Disturbance from noise and vibration from people using the office area	Moderate	ENV28 ENV29	Minor
Injury/mortality of flora and fauna from food and surface water contamination from chemical spills and sedimentation	Moderate	See Section 6.3.3	Minor

6.5.4 Decommissioning phase

There are no mitigation measures proposed in addition to those proposed for the construction phase.

6.6 Waste management

The risk of a strain on existing landfills due to the generation of non-hazardous wastes by the Project during the decommissioning stage may be significant.

- Discussions should be held with MNR and other parties regarding the fate of buried pipelines which are sometimes left in place subsequent to decommissioning by agreement of all parties (ENV30).
- This risk will be further reduced by recycling and reuse of materials/equipment where possible offsite (ENV31).

In this way, residual impact can be brought down to **minor**.

A summary of the mitigation measures and mitigated impact significance for waste management is presented in Table 6-6. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-6 Summary of decommissioning phase mitigation measures and residual impacts - waste management

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Generation and accumulation of solid wastes (i.e. materials and equipment) during decommissioning.	Moderate	ENV30 ENV31	Minor

6.7 Socio-economic

The following section outlines the mitigation and monitoring measures that will avoid, reduce or remediate the potential negative socio-economic impacts of the Project alongside measures that will enhance the potential positive socio-economic impacts.

6.7.1 Construction phase

6.7.1.1 Local economy

6.7.1.1.1 Maximise positive impacts

The following measures are proposed to maximise positive impacts related the local economy during construction:

- Opportunities for local and regional businesses to supply goods and services to the Project, generating multiplier effects across the local economy:
    - Pearl Petroleum will prioritise the sourcing of goods and services from local and regional businesses, providing required quality and delivery timescales can be met (SOC01).
    - Pearl Petroleum will support the development and capacity building of local and regional businesses, either directly or as part of government or sector-wide initiatives (SOC02).
    - Pearl Petroleum will compile an annual environmental and social performance report, made available to stakeholders, which details how local and regional businesses have been prioritised in the sourcing of goods and services and provided with capacity building support (SOC03).

6.7.1.1.2 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to the local economy during construction:

- Local price inflation indirectly arising from economic opportunities generated by the Project, leading to increased living costs for PAC members:
    - Prior to construction, a benchmarking exercise will be undertaken by Pearl Petroleum to gather data on the average price of local basic goods and services. The data will primarily be used by Pearl Petroleum to monitor changes in the cost of goods and services against baseline conditions. This information may also help to ensure there is not a large disparity between the price of goods and services procured by the Project and those purchased by local communities (SOC04).
    - Pearl Petroleum will implement a comprehensive Social Monitoring Plan that includes monitoring socio-economic changes in local communities (e.g. in living standards, household well-being and access to food and other daily necessities) through regular community meetings and through regular price surveys. The Social Monitoring Plan will be integrated into the monitoring plans implemented by Pearl Petroleum at the existing facility. Particular focus will be placed on vulnerable groups (SOC05).
    - Pearl Petroleum will undertake targeted engagements with vulnerable people should local price inflation become an issue. Based on these engagements, additional support measures (e.g. the provision of goods to vulnerable people) will be designed and implemented on a case-by-case basis with support from third parties (e.g. development agencies) as appropriate (SOC06).

- Pearl Petroleum will implement the existing Community Grievance Management Procedure to ensure that PAC residents and other stakeholders have unrestricted access and opportunity to raise concerns and grievances related to the Project (SOC07).

- Project-induced in-migration, leading to increased competition for land, housing and basic services:
  - Pearl Petroleum and contractors will jointly develop an influx management strategy (including a "no hiring at the gate" policy), providing clear information on the scale, scope and process of accessing Project-related employment and business opportunities (SOC08).
  - Information about the Project's recruitment strategy and key messages about the scale, scope and process of accessing Project-related employment and business opportunities will be given to local communities by Pearl Petroleum's Social Performance Department (SPD) to ensure that stakeholder expectations are suitably managed (SOC09).
  - Similar information and messages will be included in the worker codes of conduct used by Pearl Petroleum, contractor and sub-contractor employees in order to ensure that accurate information is conveyed to interested parties (SOC10).
  - Pearl Petroleum will implement a comprehensive Social Monitoring Plan that includes monitoring socio-economic changes in local communities (e.g. in population size, the arrival of economic migrants) through regular community meetings and other activities. The monitoring plan will be integrated into the monitoring plans implemented by Pearl Petroleum at the existing facility (SOC11).
  - Pearl Petroleum will work with, and where feasible support, local authorities in planning for and managing the spatial changes (e.g. in land use) and increasing demands on infrastructure and services that occur as the local area surrounding the Project grows (SOC12).

6.7.1.1.3 Summary

The significance of potential impacts following mitigation during construction are summarised in Table 6-7. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-7 Summary of construction phase mitigation measures and residual impacts on the local economy

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Opportunities for local and regional businesses to supply goods and services to the Project, generating multiplier effects across the local economy.	Positive	SOC01 SOC02 SOC03	Positive

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Local price inflation indirectly arising from economic opportunities generated by the Project, leading to increased living costs for PAC members.	Moderate	SOC04 SOC05 SOC06 SOC07	Minor
Project-induced in-migration, leading to increased competition for land, housing and basic services.	High	SOC08 SOC09 SOC10 SOC11 SOC12	Minor

6.7.1.2 Employment and skills development

6.7.1.2.1 Maximise positive impacts

The following measures are proposed to maximise positive impacts related to employment and skills development during construction:

- Project-related employment opportunities, leading to an improvement in household living standards and well-being:
  - Pearl Petroleum will prioritise the employment of people from local communities, followed by people from other parts of the Kurdistan Region (SOC13).
  - As part of the tendering process, contractors will be required to state the proportion of workers who will be hired from local communities and/or the wider region in order to maximise their employment opportunities. Local content targets will vary according to the scope of work being undertaken. Contractors' recruitment activities will be overseen by Pearl Petroleum's SPD to ensure adherence to local hiring requirements (SOC14).
  - Information about the Project's recruitment strategy and key messages about the scale, scope and process of accessing Project-related employment and business opportunities will be given to local communities by Pearl Petroleum's SPD to ensure that stakeholder expectations are suitably managed (SOC15).
- Project-related training opportunities, leading to improved OHS awareness and the enhancement of future employment prospects:
  - At the end of employment, workers' involvement in the Project will be formally recognised by Pearl Petroleum and contractors through the provision of references and/or certificates outlining workers' job role(s), the duration of their employment and other details (e.g. training undertaken) as appropriate (SOC16).
  - As part of the tendering process, contractors will be required to include training and competency development in order to support capacity building amongst the Project workforce and within the Project supply chain. Contractors will also be required to provide formal recognition of this training for workers (e.g. through references and/or certifications) where possible (SOC17).

- Where possible, Pearl Petroleum will provide on-the-job training to the Project workforce in order to enable workers to gain new or improved skills. Formal recognition of this training (e.g. through the provision of references and/or certifications) will be provided for workers where possible (SOC18).
- Over time, Pearl Petroleum will ensure that the proportion of foreign workers will be reduced and replaced by personnel who come from local communities and other parts of Kurdistan (SOC19).

6.7.1.2.2 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to employment and skills development during construction:

- Project-related employment opportunities, leading to skills shortages in other sectors:
  - Pearl Petroleum will gather data on average incomes associated with the public and private sector. The data will primarily be used by Pearl Petroleum to benchmark wage levels in the local area. This information may also help to ensure that there is not a large disparity between Project-related pay and pay in other sectors (SOC20).
  - Pearl Petroleum will implement a comprehensive Social Monitoring Plan that includes monitoring socio-economic changes in local communities (e.g. sources of employment, changes in wage levels) through regular community meetings and other activities. The monitoring plan will be integrated into the monitoring plans implemented by Pearl Petroleum at the existing facility (SOC21).
  - Pearl Petroleum will review its existing process for recruitment to ensure that it is able to cope with an increase in the number of jobs available as a result of the Project; changes to the existing process will be made as appropriate (SOC22).
- Unmet expectations, leading to dissatisfaction and loss of support for the Project amongst PACs:
  - Where appropriate, each contractor shall develop a Local Community Employment Plan (LCEP), prioritising the employment of people from local communities, followed by people from other parts of the Kurdistan Region. The LCEP will be developed in consultation with local authorities and will be aligned with the overarching recruitment strategy of the Project. Each contractors' recruitment activities will be overseen by Pearl Petroleum's SPD to ensure adherence to local hiring requirements (SOC23).
  - Pearl Petroleum will manage its overall relationship with local communities through a range of strategies, including regular engagement and ongoing social investment. The latter will include long-term capacity building and skills development programmes (SOC24).
  - See also SOC07 and SOC15.

- Tensions between those who benefit economically from the Project and those who do not, leading to conflict:
  - The development of LCEPs by contractors will contain provisions to ensure that Project employment opportunities for local people reflect engagement with local authorities and are perceived to be equitably distributed across the communities through ongoing engagement with village Anjuman (SOC25).
  - Pearl Petroleum's existing systems for managing conflict, for example grievances and road blocks, will be internally reviewed to ensure that they are sufficiently robust to manage conflicts which may arise as a result of the Project; changes to existing systems will be made as appropriate (SOC26).
  - See also SOC07, SOC15 and SOC24.
- Retrenchment of workers, leading to economic shock and reduced living standards at the household level[27]:
  - Contractors will be required to develop retrenchment plans with the aim of ensuring social cohesion and reducing the impacts of the termination of employment contracts. Pearl Petroleum's overall approach will be aligned with IFC guidelines on retrenchment (SOC27).
  - During the recruitment process, and for the duration of their employment, Pearl Petroleum and contractors will be transparent about the temporary nature of workers' employment on the Project and will regularly remind workers of this fact. The duration of workers' employment will be clearly stated in their employment contracts. The need to prepare for the termination of their employment contracts will also be discussed with workers (SOC28).

6.7.1.2.3 Summary

The significance of potential impacts following mitigation are summarised in Table 6-8. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings for Project related employment opportunities to below significant. For the residual significant impacts for unmet expectations, tensions and retrenchment of workers, application of the mitigation measures and accepted international practices (GIIP) result in manageable risks vis-à-vis sensitive receptors in relation to lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards.**

[27] it is possible that future facility expansion will reduce the scale of retrenchment, but no details are currently available. Therefore, this cannot be considered in the impact mitigations.

Table 6-8 Summary of construction phase mitigation measures and residual impacts on employment and skills development

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Project-related employment opportunities, leading to an improvement in household living standards and well-being.	Positive	SOC13 SOC14 SOC15	Positive
Project-related training opportunities, leading to improved OHS awareness and the enhancement of future employment prospects.	Positive	SOC16 SOC17 SOC18 SOC19	Positive
Project-related employment opportunities, leading to skills shortages in other sectors.	High	SOC20 SOC21 SOC22	Minor
Unmet expectations, leading to dissatisfaction and loss of support for the Project amongst PACs.	Major	SOC23 SOC15 SOC07 SOC24	Moderate
Tensions between those who benefit economically from the Project and those who do not, leading to conflict.	Major	SOC24 SOC25 SOC15 SOC07 SOC26	Moderate
Retrenchment of workers, leading to economic shock and reduced living standards at the household level.	Major	SOC27 SOC28	Moderate

6.7.1.3 Labour and working conditions

6.7.1.3.1 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to labour and working conditions during construction:

- Labour rights violations in the Project supply chain, leading to negative impacts on workers' health and well-being:
  - Contractors will be selected by Pearl Petroleum through a robust pre-qualification and due diligence process. Standards on labour and working conditions, aligned with those prescribed by the International Finance Corporation (IFC), will be included in all contractual documents (SOC29).
  - Contractors will develop and implement worker grievance procedures; these will be approved by Pearl Petroleum and will be aligned with Pearl Petroleum's overarching Worker Grievance Procedure. The grievance procedure will be available for use by all workers, including sub-contractor employees (SOC30).
  - Pearl Petroleum will hold regular meetings (e.g. toolbox talks) with Project personnel, including contractor and sub-contractor employees, to ensure that workers are satisfied with their employment and workplace; opportunities for workers to raise concerns and report problems will be provided at these meetings (SOC31).

- As part of the worker induction process, Contractors will be required to explain to employees (including sub-contractor employees) their legal rights and entitlements alongside the content of their employment contracts (SOC32).
- Where appropriate and feasible, Pearl Petroleum will oblige each contractor to be transparent on their supply chain. A risk-based screening assessment will prioritise the types of goods and services to be procured, which will be subject to an audit by Pearl Petroleum against national and regional regulatory requirements and international standards. Audits will include consideration of worker grievance procedures (SOC33).

- Failure to meet international OHS standards by contractors and sub-contractors, leading to increased risk of workplace accidents:
  - Contractors will develop and implement health and safety plans and work management procedures; these will be approved by Pearl Petroleum and will be aligned with Pearl Petroleum's overarching health and safety systems and international standards. Auditing will be undertaken by Pearl Petroleum to ensure contractor compliance with health and safety plans and work management procedures (SOC34).
  - OHS training programmes that are culturally and linguistically appropriate will be developed and implemented by Pearl Petroleum and contractors, as appropriate. The training programmes will be updated based on changes in the scope of work being undertaken, incident statistics and regulatory requirements (SOC35).
- Tensions within and/or between different groups of workers resulting from disparities in wages and working conditions, leading to conflict:
  - Contractors will ensure that remuneration is justified and adequate for the level of expertise and experience provided. Details of remuneration will be included in employment contracts with workers (including sub-contractor workers) (SOC36).

6.7.1.3.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-9. **Application of the mitigation measures and accepted international practices (GIIP) result in manageable risks vis-à-vis sensitive receptors in relation to lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards.**

Table 6-9 Summary of construction phase mitigation measures and residual impacts on labour and working conditions

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Labour rights violations in the Project supply chain, leading to negative impacts on workers' health and well-being.	Major	SOC29 SOC30 SOC31 SOC32 SOC33	Moderate
Failure to meet international OHS standards by contractors and sub-contractors, leading to increased risk of workplace accidents.	Major	SOC34 SOC35	Moderate
Tensions within and/or between different groups of workers resulting from disparities in wages and working conditions, leading to conflict.	Major	SOC36	Moderate

6.7.1.4 Land access and livelihoods

6.7.1.4.1 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to land access and livelihoods during construction:

- Temporary loss of access to land used for crop farming, livestock rearing and natural resource harvesting, leading to decreased income, food security and living standards:
    - Pearl Petroleum will endeavor to ensure that no Project land take will occur unless the Rental Value and Compensation Committee process has been completed such that timely compensation is paid to Project-Affected Persons (PAPs), including land users (e.g. livestock rearers). Pearl Petroleum will also endeavor to prevent access to land by Project personnel (including Pearl Petroleum staff, contractors and sub-contractors) if there is no consent or agreement in place (SOC37).
    - A Livelihood Restoration Plan (LRP) will be developed and implemented by Pearl Petroleum in order to address the short- and long-term economic impacts from temporary and permanent (life of Project) loss of access to land. The LRP will include a gap analysis of the differences between international standards and regional processes, principles of land access, an entitlements matrix based on a mitigation and compensation framework, details of the valuation of assets and establishment of compensation rates, the land access procedure, provisions for vulnerable people, Management of Change Procedure and monitoring and evaluation. The LRP will be integrated (where relevant and appropriate to do so) with the Rental Value and Compensation Committee's own activities so that compensation is paid a single time and multiple compensation payments are avoided (SOC38).

- The LRP will be supported by stakeholder engagement with the PAPs by Pearl Petroleum to ensure that the livelihood restoration strategy is clearly explained and accepted, that the approach to legacy issues is clear and that PAPs understand that they are all treated equally (SOC39).
    - The LRP will be monitored by Pearl Petroleum for a period of up to five years following implementation to assess the effectiveness of livelihood restoration measures and implement corrective actions, as appropriate (SOC40).
    - A cut-off date will be agreed between Pearl Petroleum and the Government prior to the commencement of survey activities for the LRP. The cut-off date will be clearly communicated to the PAPs (SOC41).
    - Land entry, exit and reinstatement procedures will be developed and implemented by contractors and sub-contractors working on third party lands and will include information to affected land owners and land users (SOC42).
    - See also SOC07.
- Exacerbation of existing conflicts and/or generation of new conflicts during the Project land acquisition and compensation process, leading to loss of support for the Project:
    - Pearl Petroleum will seek to support the efforts of local authorities in resolving existing conflicts over land in the Project area (SOC43).
    - Pearl Petroleum will undertake regular meetings with village Anjuman and local communities, including the PAPs, to ensure that information about the Project's land acquisition and compensation strategy is clearly communicated and that stakeholder concerns are effectively addressed (SOC44).
    - See also SOC07.
- Temporary reduction in access to watering wells and pasture land for livestock, leading to loss of livelihood and increased pressure on alternative pasture land and watering wells:
    - Pre-construction surveys will be undertaken by contractors to identify any watering wells and pasture land to which access must be maintained (SOC45).
    - During construction, the contractor will leave gaps in soil stacks and pipe strings along the RoW to ensure that access to watering wells and pasture land is maintained. Crossing points will be provided across open trenches and welded pipes as necessary (SOC46).
    - In the event that loss of access to watering wells and/or pasture land is unavoidable, alternative water supplies and pasture land/appropriate compensation will be provided by Pearl Petroleum in line with the LRP (SOC47).
- accidents involving livestock, leading to injury and potential mortality:

- Contractors' health and safety plans and work management procedures shall identify risks and contain provisions to ensure community safety, including safety barriers (e.g. fences) around open excavations to prevent local communities and livestock from falling into trenches (SOC48).
- Culturally appropriate safety signage and information will be posted in local communities and near to work sites (by Pearl Petroleum or contractors, as appropriate) to raise awareness about risks to the safety of persons and livestock (SOC49).
- See also SOC07.

6.7.1.4.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-10. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-10 Summary of construction phase mitigation measures and residual impacts on land access and livelihoods

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Temporary loss of access to land used for crop farming, livestock rearing and natural resource harvesting, leading to decreased income, food security and living standards.	Major	SOC37 SOC38 SOC39 SOC40 SOC41 SOC42 SOC07	Minor
Exacerbation of existing conflicts and/or generation of new conflicts during the Project land acquisition and compensation process, leading to loss of support for the Project.	High	SOC43 SOC07 SOC44	Minor
Temporary reduction in access to watering wells and pasture land for livestock, leading to a loss of livelihood and increased pressure on alternative pasture land and watering wells.	High	SOC45 SOC46 SOC47	Minor
Accidents involving livestock, leading to injury and potential mortality.	High	SOC48 SOC49 SOC07	Minor

6.7.1.5 Community safety and security

6.7.1.5.1 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to community safety and security during construction:

- Increased risk of accidents involving community members at work sites, leading to injury and potential mortality:
  - Contractors' health and safety plans shall identify risks and contain provisions to ensure community safety, including safety barriers (e.g. fences) around open excavations to prevent local communities and livestock from falling into trenches (SOC48).
  - Culturally appropriate safety signage and information will be posted in local communities and near to work sites (by Pearl Petroleum or contractors, as appropriate) to raise awareness about risks to the safety of persons and livestock (SOC49).
  - A community safety awareness campaign will be developed and implemented by Pearl Petroleum in local communities with a particular focus on high-risk groups (e.g. children) which may involve school visits to raise awareness on road safety risks (SOC50).
- Increased volume of traffic leads to an increased risk of road traffic accidents involving community members:
  - Where appropriate, each contractor will develop a work-specific Traffic Management Plan (TMP) which identifies sensitive social receptors along transportation routes and outline mitigation measures (e.g. speed limit restrictions, vehicle maintenance activities, awareness campaigns, recruitment of traffic wardens) to reduce the risk of road traffic accidents occurring (SOC51).
  - See also SOC50.
- Tensions between non-local workers and members of the PACs, leading to conflict:
  - Contractors will develop and implement workers' codes of conduct; these will be approved by Pearl Petroleum, will be aligned with Pearl Petroleum's existing code of conduct for workers and will include training for all Project personnel on local customs, culture and tradition, interacting with local communities, expected behaviour and the Community Grievance Management Procedure. This training will be delivered as part of the worker induction process. Compliance with workers' codes of conduct will be a contractual requirement for all employees, including sub-contractor employees (SOC52).
  - The out-of-hours movement of non-local workers (from other parts of Kurdistan or further afield), for reasons not related to work, will be prohibited by Pearl Petroleum in accordance with construction camp rules (SOC53).
- Negative interactions between community members and Project security personnel, leading to conflict and potentially the inappropriate use of force:
  - Established arrangements for security provision at the existing facility will be reviewed by Pearl Petroleum to ensure that they are sufficiently robust

to manage security issues which may arise as a result of the Project; changes to existing arrangements will be made as appropriate (SOC54).

    - Pearl Petroleum will ensure that training for Project security personnel includes rules of engagement and human rights (e.g. the Voluntary Principles of Security and Human Rights) (SOC55).

- Dissatisfaction with the handling of social issues by the Project amongst PAC members, leading to an increase in the number of road blocks and other forms of protest:
    - Pearl Petroleum will undertake regular meetings with village Anjuman and local communities to ensure that information about the Project is clearly communicated and that stakeholder concerns are effectively addressed (SOC56).
    - Pearl Petroleum will implement a comprehensive Social Monitoring Plan that includes monitoring relations between local communities and the Project and any changes in perceptions towards Pearl Petroleum through regular community meetings and other activities. The Social Monitoring Plan will be integrated into the monitoring plans implemented by Pearl Petroleum at the existing facility (SOC57).
    - Pearl Petroleum will provide local communities with regular updates on the Project through community meetings; reporting to local communities will be integrated within the overarching Stakeholder Engagement Plan (SEP) that is implemented by Pearl Petroleum at the existing facility (SOC58).
    - See also SOC07 and SOC24.
- Anxiety, irritation and a reduction in overall well-being amongst the PACs resulting from gas flaring during non-routine events:
    - Pearl Petroleum's SEP shall be reviewed to ensure that information on Project activities such as the potential for non-routine flaring events to occur occasionally is included; updates to the SEP will be made, as appropriate (SOC59).
    - See also SOC07.

6.7.1.5.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-11. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-11 Summary of construction phase mitigation measures and residual impacts on community safety and security

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Increased risk of accidents involving community members at work sites, leading to injury and potential mortality.	Major	SOC48 SOC49 SOC50	Minor
Increased volume of traffic, leading to an increased risk of road traffic accidents involving community members.	Major	SOC51 SOC50	Minor
Tensions between non-local workers and members of the PACs, leading to conflict.	High	SOC52 SOC53	Minor
Negative interactions between community members and Project security personnel, leading to conflict and potentially the inappropriate use of force.	High	SOC54 SOC55	Minor
Dissatisfaction with the handling of social issues by the Project amongst PAC members, leading to an increase in the number of road blocks and other forms of protest.	High	SOC24 SOC07 SOC56 SOC57 SOC58	Minor
Anxiety, irritation and a reduction in overall well-being amongst the PACs resulting from gas flaring during non-routine events.	High	SOC59 SOC07	Minor

6.7.1.6 Public health

6.7.1.6.1 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to public health during construction:

- Transmission of new communicable diseases between the non-local and local Project workforce, leading to a reduction in health and well-being at the community level and increased pressure on local health care facilities:
    - Contractors' health and safety plans shall contain provisions to ensure the fitness of workers (e.g. pre-deployment medical screenings which includes tests for communicable diseases) during the recruitment process; these will be aligned with the provisions contained within Pearl Petroleum's overarching health and safety systems (SOC60).
    - Contractors' health and safety plans shall include health and hygiene training for all employees, including sub-contractor employees, to minimise the spread of communicable diseases (SOC61).
- Anxiety, irritation and reduced well-being amongst PACs resulting from an increase in ambient noise levels:
    - See mitigation measures in Section 6.4 (Noise).

- Contractors' health and safety plans shall identify the risks to public health associated with their scope of work and detail mitigation measures as appropriate (SOC62).
    - See also SOC07.
- Increase in respiratory conditions or exacerbation of existing respiratory conditions resulting from a decline in local air quality:
    - See mitigation measures in Section 6.1.1 (Air Quality).
    - See also SOC07 and SOC62.

6.7.1.6.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-12. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-12 Summary of construction phase mitigation measures and residual impacts on public health

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Transmission of new communicable diseases between the non-local and local Project workforce, leading to a reduction in health and well-being at the community level and increased pressure on local health care facilities.	Moderate	SOC60 SOC61	Minor
Anxiety, irritation and reduced well-being amongst PACs resulting from an increase in ambient noise levels.	Moderate	See Noise Section 6.4 SOC62 SOC07	Minor
Increase in respiratory conditions or exacerbation of existing respiratory conditions resulting from a decline in local air quality.	Moderate	See Air Quality Section 6.1.1 SOC62 SOC07	Minor

6.7.1.7 Infrastructure and services

6.7.1.7.1 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to infrastructure and services during construction:

- Deterioration in existing road conditions, leading to vehicle damage, longer journey times and increased risk of accidents for local people:
    - A pre-construction survey will be undertaken (by Pearl Petroleum or contractor, as appropriate) to assess the condition of roads to be used by

the Project (including but not limited to traffic signage, bridges and other road infrastructure) (SOC63).

    - A post-construction survey will be undertaken (by Pearl Petroleum or contractor, as appropriate) covering all of the areas surveyed pre-construction to assess the condition of roads and road-related infrastructure used by the Project; any actions (e.g. repairs) arising from the post-construction survey will be closed out in a timely manner (SOC64).
    - Where appropriate, each contractor will develop a work-specific Traffic Management Plan (TMP) which will include restrictions on vehicle movements to defined access routes and demarcated work areas (SOC65).
    - See also SOC07.
- Improper handling and disposal of Project waste, leading to a deterioration in environmental conditions and potential outbreak of diseases:
    - See also SOC07 and SOC62.
- Use of local health services by contractor and sub-contractor employees, leading to negative outcomes for health care provision for the PACs:
    - As part of the worker induction process, Contractors will be required by Pearl Petroleum to communicate that medical assistance to all employees (including sub-contractor employees) is provided by the Project. Workers will be prohibited from using local health services at this time (SOC66).
- Blame directed towards the Project by PAC members over perceived reduction in access to water, leading to loss of support for the Project:
    - Pearl Petroleum will monitor water supplies in local communities against baseline conditions; the monitoring plan will be integrated into monitoring plans implemented by Pearl Petroleum at the existing facility (SOC67).
    - Pearl Petroleum will develop and implement water efficiency training programmes in local communities with the aim of promoting sustainable water consumption (SOC68).
    - See also SOC56, SOC57 and SOC58.
- Upgrading, movement or damage to community infrastructure, leading to loss of access and/or power for households and public services:
    - Pre-construction surveys will be undertaken (by Pearl Petroleum or contractor, as appropriate) to identify community infrastructure (e.g. bridges, electricity pylons, power lines) which will need to be upgraded, moved or will be potentially damaged by the Project (SOC69).
    - Any planned activities which may affect community infrastructure (e.g. bridges, electricity pylons, power lines) will be communicated to local authorities and affected communities by Pearl Petroleum in a timely manner. Information provided to stakeholders will include (but not be

limited to) the nature, timing and duration of the planned activities (SOC70).

- Any damage to community infrastructure will be repaired in a timely manner by the contractor (SOC71).
- See also SOC07 and SOC58.

6.7.1.7.2 Summary

The significance of potential impacts following mitigation are presented in Table 6-13. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-13 Summary of construction phase mitigation measures and residual impacts on infrastructure and services

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Deterioration in existing road conditions, leading to vehicle damage, longer journey times and increased risk of accidents for local people.	High	SOC63 SOC64 SOC65 SOC07	Minor
Improper handling and disposal of Project waste, leading to a deterioration in environmental conditions and potential outbreak of diseases.	High	SOC62 SOC07	Minor
Use of local health services by contractor and sub-contractor employees, leading to negative outcomes for health care provision for the PACs.	High	SOC66	Minor
Blame directed towards the Project by PAC members over perceived reduction in access to water, leading to loss of support for the Project.	High	SOC56 SOC57 SOC67 SOC68 SOC58	Minor
Upgrading, movement or damage to community infrastructure, leading to loss of access and/or power for households and public services.	High	SOC69 SOC70 SOC71 SOC07 SOC58	Minor

6.7.1.8 Traffic on access roads near the Project site

6.7.1.8.1 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to traffic during construction:

- Pearl Petroleum will request permission from the Erbil Directorate of Roads and Bridges to implement any road diversion and will provide prior notification to the public and appropriate road signage before any road diversions (SOC72).

- Pearl Petroleum will seek to avoid diversions during peak hours or creating blockages or diversions during peak activities on weekends (SOC73).
- The physical condition of the road will be monitored on an as needed basis, to raise concerns and work with the local governments to make repairs (SOC74).

6.7.1.8.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-14. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-14 Summary of construction phase mitigation measures and residual impacts on traffic

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Interference with users of the public road network arising from temporary road closures and deviations.	High	SOC72 SOC73	Minor
Deterioration of the physical condition of the public road network.	High	SOC74	Minor

6.7.1.9 Vulnerable groups

6.7.1.9.1 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to vulnerable groups during construction:

- Reduced ability of vulnerable groups to access Project-related economic benefits, leading to increased levels of vulnerability and inequality:
  - Pearl Petroleum will identify vulnerable groups in its SEP and provide targeted assistance, where possible and appropriate, to ensure that they have equal access to Project-related information and equal opportunities to raise questions and concerns (SOC75).
  - Pearl Petroleum will ensure that recruitment processes for the Project are based on the skills required for the role with no discrimination according to age, sexuality or gender, ethnicity, religion and/or political opinion (SOC76).
  - Illiterate persons will continue to be provided with additional support by Pearl Petroleum when applying for jobs on the Project (SOC77).
- Reduced ability of women to access Project-related economic benefits, leading to increased levels of gender inequality:
  - Pearl Petroleum will develop and implement a gender inclusion strategy containing various measures to promote the inclusion of women in the Project. The strategy will firstly assess the barriers to female participation

in the Project workforce and seek to identify short-, medium- and long-term actions to address them. Consideration will be given to including, for example, recruitment targets for women for contractors and sub-contractors, provisions to ensure women feel safe in the workplace and in Project accommodation and provisions to ensure that women are fairly engaged with during the recruitment process. Where appropriate and feasible, the Project will work in partnership with third parties (e.g. development agencies) to develop and implement the gender inclusion strategy. The provisions of the gender inclusion strategy will be integrated into management plans for the Project, as appropriate (SOC78).

    - See also SOC76.

- Challenges to power structures and social dynamics as a result of women's employment by the Project, leading to an increase in conflict and GBV amongst households:
    - As part of the gender inclusion strategy, the potential risks that may be associated with women's participation in the Project will be assessed by Pearl Petroleum. Measures to mitigate these risks in the short-, medium- and long-term will be identified. Consideration will be given to, for example, targeted engagements with men to raise awareness about the benefits associated with women's involvement in the Project (SOC79).
- Reduced ability of vulnerable groups to effectively engage and participate in the Project land acquisition and compensation process, leading to discrimination and increased inequality:
    - A comprehensive survey to establish the vulnerability of flowline land owners and land users will be undertaken as part of the LRP (SOC80).
    - Based on the results of the survey, the LRP will specify additional support measures to ensure that vulnerable people are not disadvantaged during the Project land acquisition and compensation process (SOC81).
- Reduced ability of vulnerable groups to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits:
    - See SOC75.
- Reduced ability of women to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits:
    - Pearl Petroleum will ensure that its Stakeholder Engagement Plan (SEP) provides special measures, where possible and appropriate, to ensure that women have equal access to Project-related information and equal opportunities to raise questions and concerns (SOC82).

6.7.1.9.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-15. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings to below significant for**

- reduced ability of vulnerable groups to access Project-related economic benefits, leading to increased levels of vulnerability and inequality
- reduced ability of vulnerable groups to effectively engage and participate in the Project land acquisition and compensation process, leading to discrimination and increased inequality
- reduced ability of vulnerable groups to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits.

The application of the mitigation measures and accepted international practices (GIIP) result in manageable risks vis-à-vis sensitive receptors in relation to lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards for the residual significant impacts for

- reduced ability of women to access Project-related economic benefits, leading to increased levels of gender inequality
- challenges to power structures and social dynamics as a result of women's employment by the Project, leading to an increase in conflict and GBV amongst households
- reduced ability of women to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits.

Table 6-15 Summary of construction phase mitigation measures and residual impacts on vulnerable groups

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Reduced ability of vulnerable groups to access Project-related economic benefits, leading to increased levels of vulnerability and inequality.	High	SOC75 SOC76 SOC77	Minor
Reduced ability of women to access Project-related economic benefits, leading to increased levels of gender inequality.	High	SOC78 SOC76	Moderate
Challenges to power structures and social dynamics as a result of women's employment by the Project, leading to an increase in conflict and GBV amongst households.	Major	SOC79	Moderate
Reduced ability of vulnerable groups to effectively engage and participate in the Project land acquisition and compensation process, leading to discrimination and increased inequality.	High	SOC80 SOC81	Minor
Reduced ability of vulnerable groups to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits.	High	SOC75	Minor
Reduced ability of women to access Project-related information, leading to lower levels of awareness about the Project and the potential associated benefits.	High	SOC82	Moderate

6.7.2 Pre-commissioning and commissioning phases

The following mitigation and monitoring and enhancement measures, proposed for the construction phase of the Project (see Section 6.7.1), are also applicable during pre-commissioning and commissioning:

- SOC01 through SOC07
- SOC13 through SOC36
- SOC52 through SOC58
- SOC60 through SOC62
- SOC66
- SOC75 through SOC79
- SOC82.

For the additional impacts identified during pre-commissioning and commissioning, the following mitigation and monitoring measures are proposed.

6.7.2.1 Infrastructure and services

6.7.2.1.1 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to infrastructure and services during pre-commissioning and commissioning:

- Association of hydrotesting with problems surrounding local water quality and quantity, leading to a loss of support for the Project amongst PAC members:
    - Prior to the commencement of hydrotesting, Pearl Petroleum will develop and implement a targeted community information campaign on hydrotesting to ensure that local communities understand the noise, water and any other impacts associated with this exercise (SOC83).

6.7.2.1.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-16. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-16 Summary of pre-commissioning and commissioning phase mitigation measures and residual impacts on infrastructure and services

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Association of hydrotesting with problems surrounding local water quality and quantity, leading to a loss of support for the Project amongst PAC members.	High	SOC83	Minor

6.7.3 Operations phase

The following mitigation and monitoring and enhancement measures, proposed for the construction phase of the Project (see Section 6.7.1), are also applicable during operations:

- SOC01 through SOC07
- SOC13 through SOC26
- SOC29 through SOC36
- SOC52 through SOC58
- SOC60 through SOC68
- SOC72 through SOC79
- SOC82.

For impacts identified during operations only, the following mitigation and monitoring and enhancement measures are proposed.

6.7.3.1 Regional economy

6.7.3.1.1 Maximise positive impacts

The following measures are proposed to maximise positive impacts related to the regional economy during operations:

- Contribution of the Project to the development of Kurdistan's oil and gas sector and regional economic growth:
    - Pearl Petroleum will seek to maximise this benefit as far as possible through, for example, considering opportunities to work with universities as part of the SIPs to support additional knowledge transfer and/or the use of technology that promotes the efficiency of power supply systems (SOC84).
    - Pearl Petroleum will develop a draft plan for providing transition training to allow skilled employees to better access employment in other sectors; the level of interest in such training amongst workers will be evaluated prior to the finalisation and implementation of the plan (SOC85).

6.7.3.1.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-17.

Table 6-17 Summary of operations phase mitigation measures and residual impacts on the regional economy

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Contribution of the Project to the development of Kurdistan's oil and gas sector and regional economic growth.	Positive	SOC84 SOC85	Positive

6.7.3.2 *Land access and livelihoods*

6.7.3.2.1 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to land access and livelihoods during operations:

- Restriction on the rights of crop farmers to use and to develop land during the operation of the Project, leading to limitations on the types of crops grown and used to generate income:
    - Where the Project affects the livelihood activities of crop farmers, appropriate compensation will be provided in line with the LRP (SOC86).
    - See also SOC07.

6.7.3.2.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-18. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-18 Summary of operations phase mitigation measures and residual impacts on land access and livelihoods

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Restriction on the rights of crop farmers to use and to develop land during the operation of the Project, leading to limitations on the types of crops grown and used to generate income.	High	SOC86 SOC07	Minor

6.7.3.3 *Community safety and security*

6.7.3.3.1 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to community safety and security during operations:

- Health and safety risks for local communities, the local environment and the Project workforce due to interference or tampering with Project infrastructure by community members, leading to environmental damages, injury and potential mortality:
    - Culturally appropriate safety warnings and information will be posted in local communities and near to Project infrastructure by Pearl Petroleum to raise awareness about the risks of interfering or tampering with Project infrastructure (SOC87).
    - Pearl Petroleum will develop and implement community safety awareness campaigns in local communities with the aim of discouraging interference or tampering with Project infrastructure (SOC88).

- Emergency response planning is addressed in Section 11.

6.7.3.3.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-19. **The mitigation measures allow full compliance with lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards, and reduce residual impacts ratings below significant.**

Table 6-19 Summary of operations phase mitigation measures and residual impacts on community safety and security

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Health and safety risks for local communities, the local environment and the Project workforce due to interference or tampering with Project infrastructure by community members, leading to environmental damages, injury and potential mortality.	Major	SOC87 SOC88 Emergency response planning (see Section 11)	Minor

6.7.3.4 Traffic on access roads near the Project site

Pearl Petroleum will apply the same mitigation measures developed for the construction phase (see Section 6.7.1.8).

6.7.3.5 Visual impacts

6.7.3.5.1 Proposed mitigation and monitoring measures

Measures to reduce the impact of night-time non-routine flaring leading to disturbance of well-being of residents of local communities, for example installation of glazed windows or shades for residences with a clear view of the flare (S0C89).

6.7.3.5.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-20. **Application of the mitigation measures and accepted international practices (GIIP) result in manageable risks vis-à-vis sensitive receptors in relation to lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards.**

Table 6-20 Summary of operations phase mitigation measures and residual visual impacts

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Night time non-routine flaring leading to disturbance of well-being of residents of local communities	High	SOC89	Medium

6.7.4 Decommissioning phase

The following mitigation and monitoring measures, proposed for the construction phase of the Project (see Section 6.7.1), are also applicable during decommissioning:

- SOC27
- SOC28
- SOC72 through SOC74.

For additional impacts identified during decommissioning, the following mitigation and monitoring measures are proposed.

6.7.4.1 Infrastructure and services

6.7.4.1.1 Proposed mitigation and monitoring measures

The following mitigation measures are proposed to limit the potential for impacts related to infrastructure and services during decommissioning:

- Deterioration in PAC living standards and well-being if the PACs become dependent on Pearl Petroleum and related economic opportunities, support and services are withdrawn:
    - As part of its ongoing social investment in local communities, Pearl Petroleum will develop and implement programmes which promote the long-term sustainability and independence of communities. The avoidance of dependency will be considered in the design of all SIPs and planning for the end of Pearl Petroleum interventions will be considered from the outset (SOC90).
    - Consideration will be given to technical solutions to sharing costs and accountability for the provision of power and water by Pearl Petroleum (SOC91).
    - Consideration will be given by Pearl Petroleum to prioritising social investment that diversifies the local economy and reduces local communities' reliance on Pearl Petroleum at Khor Mor (SOC92).
    - Consideration will be given to skills and training to support regional development priorities by Pearl Petroleum (SOC93).
    - Consideration will be given to strategic engagement structures, such as community committees and participatory monitoring, to build community capacity to manage their development by Pearl Petroleum (SOC94).

- Consideration will be given by Pearl Petroleum to leveraging its operations at Khor Mor to encourage other development entities to engage in the area (SOC95).
- Consideration will be given to working in partnership with third parties (e.g. development agencies) by Pearl Petroleum to implement the SIPs (SOC96).
- See also SOC24.

6.7.4.1.2 Summary

The significance of potential impacts following mitigation are summarised in Table 6-21. **Application of the mitigation measures and accepted international practices (GIIP) result in manageable risks vis-à-vis sensitive receptors in relation to lender requirements (including but not limited to the IFC PS and EHS guidelines) and other Project Standards.**

Table 6-21 Summary of decommissioning phase mitigation measures and residual impacts on infrastructure and services

Potential impact	Unmitigated impact significance	Mitigation measures	Residual impact significance
Deterioration in PAC living standards and well-being if the PACs become dependent on Pearl Petroleum and related economic opportunities, support and services are withdrawn.	Major	SOC24 SOC90 SOC91 SOC92 SOC93 SOC94 SOC95 SOC96	High

6.8 Associated facilities

Potential impacts of the five production wells to be installed were described in Section 5.11. High-level mitigation measures (similar to those described for the KM250A Project) for those impacts that may be significant are presented in Table 6-22. The five new production wells will be subject to an additional detailed ESIA to confirm the impacts and mitigation measures presented.

Table 6-22 Mitigation measures for associated facilities (five production wells)

Area of concern	Potential impact	Mitigation measure(s)
Air quality	Dust (particulate matter)	Standard GIIP measures to be applied (see Section 6.1).
	Emissions from diesel generators, vehicles and other equipment, including CO, CO_2, NOx, SO_2, H_2S, VOCs and particulate matter	
	Flaring	Modelling during the new well ESIA.
Water resources and soil	Loss of vegetation cover leading to erosion and changes in natural drainage patterns	ENV03 - ENV07
	On-site storage and handling of fuels and chemicals leading to leaks/spills and reduced groundwater quality	
	Diesel tanker truck leaks or spills	
	On-site refuelling	
	Groundwater abstraction leading to aquifer drawdown	
Biodiversity	Breeding and foraging habitat loss for small mammals and avifauna from vegetation clearance on project footprint	ENV13 - ENV22 and ENV24 - ENV29
	Noise and vibration from construction and drilling equipment causing temporary displacement of species from breeding and foraging habitat	ENV13 - ENV25 and ENV27 - ENV29
	Potential contamination from accidental releases of fuel or drilling related fluids of food and water sources used by fauna	ENV06 and ENV07
	Noise and light disturbance from flaring causing temporary displacement of fauna from breeding and forage habitat	ENV29
Waste management	Waste pits	After the disposed material has dried out, the pits should be capped with clay and backfilled with excavated subsoil.
Socio-economic – local economy	Opportunities for local and regional businesses to supply goods and services, generating multiplier effects across the local economy.	SOC01 to SOC03
	In-migration, leading to increased competition for land, housing and basic services.	SOC08 to SOC12
Socio-economic – employment	Employment opportunities, leading to an improvement in household living standards and well-being.	SOC13 to SOC15
	Training opportunities, leading to improved OHS awareness and the enhancement of future employment prospects.	SOC16 to SOC19

Area of concern	Potential impact	Mitigation measure(s)
and skills development	Unmet expectations, leading to dissatisfaction and loss of support for the production wells amongst PACs. Tensions between those who benefit economically and those who do not, leading to conflict.	SOC07, SOC15, SOC23 and SOC24 to SOC26
	Retrenchment of workers, leading to economic shock and reduced living standards at the household level.	SOC27 and SOC28
Socio-economic – labour and working conditions	Labour rights violations in the supply chain, leading to negative impacts on workers' health and well-being. Failure to meet international OHS standards by contractors and sub-contractors, leading to increased risk of workplace accidents.	SOC29 to SOC35.
Socio-economic – land access and livelihoods	Loss of access to land used for crop farming, livestock rearing and natural resource harvesting, leading to decreased income, food security and living standards.	SOC07 and SOC37 to SOC42
	Exacerbation of existing conflicts and/or new generation of new conflicts during the land acquisition and compensation process, leading to loss of support by PACs.	SOC07, SOC43 and SOC44
Socio-economic – community safety and security	Increased volume of traffic, leading to increased noise levels and an increased risk of road traffic accidents involving community members and livestock.	SOC50 and SOC51
	Negative interactions between community members and security personnel, leading to conflict and potentially the inappropriate use of force.	SOC54 and SOC55
	Anxiety, irritation and a reduction in overall well-being amongst the PACs resulting from the noise and light generated by gas flaring.	SOC07 and SOC59
Socio-economic – infrastructure and services	Deterioration in existing road conditions, leading to vehicle damage, longer journey times and increased risk of accidents for local people.	SOC07 and SOC63 to SOC65
	Blame directed towards the production wells by PAC members over perceived reduction in access to water, leading to loss of support amongst PACs.	SOC56 to SOC58, SOC67 and SOC68
Socio-economic – vulnerable groups	Reduced ability of vulnerable groups and women to access economic benefits, leading to increased levels of vulnerability and inequality.	SOC75 to SOC78
	Reduced ability of vulnerable groups to effectively engage and participate in the land acquisition and compensation process, leading to discrimination and increased inequality.	SOC80 and SOC81
	Reduced ability of vulnerable groups and women to access information, leading to lower levels of awareness about the production wells and the potential associated benefits.	SOC75 and SOC82

7 KEY OPTIONS AND ALTERNATIVES

7.1 Introduction

All activities associated with the KM250A Project other than road transport, the flowlines, and operation of the well pads, are to be located within the existing, fenced boundary of the site. The flowline corridors will fall outside the site boundary; final routing of these corridors will take into consideration any concerns identified with respect to field surveys and conclusions of this environmental and social impact assessment (ESIA). The siting of the new access gate and truck inspection building will similarly take into consideration the findings of the ESIA.

Pearl Petroleum has considered various technology, process and operating regime alternatives during the FEED stage of the Project. Final selection of technology and processes will be recommended by the EPC Contractor to Pearl Petroleum once that contractor has been selected. This is to be determined based on:

- potential environmental and social impacts and ensuing that the Project Standards associated with emissions and effluent limits are achieved during routine operations
- occupational health and safety risks to the workforce and process safety risks to local communities
- reliability and operability
- CAPEX and OPEX.

The principles and techniques applied during the Project life cycle will be tailored to the hazards and risks associated with the Project and consistent with good international industry practice (GIIP), as reflected in various internationally recognised sources, including the IFC Performance Standards on Environmental and Social Sustainability (IFC PS) (2012) and the accompanying IFC Environmental, Health and Safety (EHS) Guidelines (see Section 9.8.1 and 9.8.2).

7.2 Technical alternatives considered

Alternative technologies and designs have been considered for various aspects of the Project during the pre-FEED work. The key alternatives considered for the Project are shown in Table 7-1. In addition to the alternatives given in Table 7-1, there are some features that add value to the engineering concepts:

- use of gas engine drivers for sales gas compression and power generation, which increases plant availability, reduces unplanned maintenance and avoids the use of diesel engines to generate power
- plot plan layout to ensure safe locations for occupied buildings (for example the control room)
- equipment spacing to enhance safety and allow future simultaneous operations (SIMOPS) when installing future plants
- civils drainage design to minimise impact on the existing water catchment areas.

7.3 'Do nothing' alternative

As per KRI ESIA legal requirements and guidelines, the "Do nothing" alternative also need to be considered. Under this alternative, no positive or negative environmental or social impacts would be realised. However, the 'Do nothing' alternative is not a viable option since it would compromise compliance of Pearl Petroleum's commitment to the KRG under the Gas Sales Agreement and, consequently, it would not fulfil the KRG's goals to expand oil and gas exploration and production capacity.

Table 7-1 Key alternatives considered in the KM250A Project

Requirement	Alternative methods		Key Issues	Selected Option
	Design	Technology options		
Gas dehydration	KM250A gas processing facility will receive the raw gas from the production wells and further processing of the inlet raw gas will be conducted at the KM250A premises and the final products including sales gas, LPG and condensate will be exported to the end-users via pipeline or trucks. Sales gas must meet specifications for moisture content. Raw gas must therefore be dehydrated to meet these specifications.	Molecular sieve vs. glycol	There are no key constriants in using either of the options, however using molecular sieve can reduce the air emissions, as there are no hydrocarbon and aromatic emissions expected and there will be no chemical spillage. Glycol needs to transported to the site in regular quantities, added at the wellhead and then ultimately removed from the raw gas stream (to the extent possible). This is an expensive option and I suspect this is an advantage over the sieve.	Molecular sieve
Compression	Compression of gas will be required at various parts of the gas treatment process.	Centrifugal vs. reciprocating compressors	There are no key constraints in using either of the options, however centrifugal compressors generate less noise and increase availability by reducting maintenance requirements	Reciprocating compressors (rental) will be used for the KM250A Project. Reciprocating compressors are used for the flash gas compressor and for the de-ethaniser overhead compessor. Centrifugal compressors will only be installed post KM1000 Expansion.

Requirement	Alternative methods		Key Issues	Selected Option
	Design	Technology options		
Gas desulphurisation	Raw gas must be desulphurised in order to meet product sulphur content specifications	Di-ethylamine (DEA) vs. methyl di-ethylamine (MDEA) units	DEA units have higher CAPEX than MDEA units, however DEA units have lower OPEX (especially with respect to the regeneration system reboiler fuel). DEA units have higher operational efficiency, which will reduce reboiler fuel requirements. DEA can accommodate higher process gas operating temperatures than MDEA (MDEA units are limited to 55°C process gas temperature). As the maximum inlet temperature to the amine column will rise once inlet compression is installed, MDEA is unsuitable.	DEA
Mercury removal	Mercury removal is included because aluminium plate-fin exchangers are selected for the LPG recovery section. It also eliminates mercury HSE concerns for maintenance personnel.	Metal sulphide system vs. other mercury extraction systems	A non-regenerable metal sulphide has been selected (same as existing Cryo#). It is located downstream of the dehydration system as it can share the same liquids protection system and is not part of the dehydration regeneration circuit system even if this increases plant dry out time (absorbent only replaced every 5-10 years).	Metal sulphide sytem

Requirement	Alternative methods		Key Issues	Selected Option
	Design	Technology options		
Disposal of acid waste gas from sulphur removal	The Project has selected a thermal oxidiser for disposing of waste acid gas (H_2S) with future provision for installing a sulphur recovery unit (SRU) or other solution to be selected during the EPC detailed design phase. The H_2S is combusted, resulting in emissions of SO_2.	Acid gas thermal oxidiser vs. SRU (or other solution)	For the KM250A Project a thermal oxidiser is to be installed largely to eliminate H_2S and minimise the CAPEX for the Project. Production rates of H_2S will be limited for the KM250A Project. Once gas production is increased through future KM expansions a SRU will be installed to accommodate higher overall volumes of H_2S.	Acid gas thermal oxidiser
Disposal of vent gas from new condensate storage tank.	Vent gas from condensate storage is to be routed to an 'LLP' flare remote from the storage tank on a continuous basis.	Options are: Cold vent from the top of the tank Cold vent remote from the tanks Flare remote from the tanks Vapour recovery unit to recover VOCs Install a second condensate export pipeline in the future to eliminate the need for additional condensate storage.	Health and safety risks associated with cold venting from the top of the tank mean this option is not in alignment with GIIP, as condensate vapours can contain hazardous components. Cold venting remote from the tanks (that is, the existing condensate storage tank and the to be built KM250A Project condensate storatge take, vents for which will be connected) only has a marginal cost saving over flaring. A condensate export pipeline to Chemchemal is expected to be installed in circa 2 years, which means that investment in a vapour recovery unit for condensate tank offgas is not justified (condensate will enter the pipelie directly from the process; condensate storage tanks will only be used in emergencies). Emissions from	LLP flare

Requirement	Alternative methods		Key Issues	Selected Option
	Design	Technology options		
			condensate storage will be signifiicantly reduced once the condensate export pipeline is installed. A vent/flare would still be requried for vent gas even if a vapour recovery unit were installed to allow for shutdown of the vapour recovery unit during maintenance periods.	
Disposal of vent gas from tanker loading facility?	Vent gas from tanker loading facility is routed to a cold vent (with forced air dilution) located close to the tanker loading station.	Options are: Cold vent from each tanker Cold vent remote from the tanker loading Flare remote from the tanker loading Combined LLP flare for tanker loading and storage tank venting Vapour recovery unit to recover VOCs Install a second future condensate export pipeline to remove the need for tanker loading	Installation of a second pipeline would move the tanker loading venting to Chemchemal. Occupational Health and Safety risks as well as risk of fire or explosion associated with cold venting from the top of the tankers mean this option is not acceptable. Cold venting is not aligned with GIIP. A condensate export pipeline to Chemchemal is expected to be installed in circa two years which means that the investment in a vapour recovery unit is not justified as the duration of emissions will be time limited. Emissions from tanker loading will transfer to Chemchemal truck loading facilities once the condensate export pipeline is installed. There is not expected to be any venting from truck loading at KM	Cold vent remote from the tanker loading.

Requirement	Alternative methods		Key Issues	Selected Option
	Design	Technology options		
			once the new condensate export pipeline to Chemchemal is installed such that investment in a flare is not considered appropriate. Connecting the tanker vent with the condensate tank vent that goes to the LLP flare would entail significant cost and design complexity. A vent/flare would still be required for vent gas even if a vapour recovery unit were installed to allow for a shutdown of the vapour recovery unit.	
Export of sales gas	Sales gas from KM250A is to be exported via the existing 24” pipeline with gas pressure boosted at Khor Mor by temporary compression.	Install a new gas export pipeline as part of the KM250A Project	The cost and lead time of a new gas export pipeline would significantly affect KM250A Project economics. The Project start-up would need to be delayed and the initial CAPEX would be significnatly higher. Temporary compression involves energy usage (fuel gas) to export sales gas.	Export via the existing 24” pipeline utilising temporary booster compression.
Single compression stage for flash gas Compression	Gas leaves the condensate stabiliser feed separator and condensate stabiliser at relatively low pressure . This gas needs to be captured and compressed in order to return the gas to the gas processing section of the plant. A single stage compressor has been	Use a two-stage compressor Vent/flare flash gas	The volumes of flash gas are relatively high and flash gas contains high concentrations of H_2S, such that venting/flaring of flash gas would produce a high environmental impact. Use of a two-stage compressor would entail additional CAPEX and the energy usage for compression would be higher.	

Requirement	Alternative methods		Key Issues	Selected Option
	Design	Technology options		
	selected; this allows operation at the minimum pressure required by the condensate stabiliser. This results in a higher operating temperature and reboiler energy usage.			
To hydrocarbon dewpoint sales gas to meet the export specification and recover LPG	Raw gas needs to be chilled to cause heavy ends (C_{3+}) to drop out of the gas phase and be recovered as condensate/LPG.	Turboexpander/recompressor J-T valve Refrigeration Shell and tube HX vs aluminium plate fin exchanger	Turbo-expander/recompressor results in lower compression costs (and energy usage) compared to J-T valve operation. Refrigeration would entail high CAPEX. Aluminium plate fin exchanger is far more efficient at energy recovery than a shell and tube exchanger.	Turboexpander/recompressor with a aluminimum plate fin exchanger pre-cooler.
Location of condensate/oil storage and oil plant	Need for 'cut and fill' for ensuring level storage tank areas	Possibility of maintaining the elevation higher than the process plant elevation vs. keeping originally expected location at same elevation of process plant.	Move the condensate/oil storage and oil plants further south, away from the processing facilities, by extending the southern site boundary further south. Locating at higher location will reduce future cut and fill volume even if this is not considered best industry practice.	Tanks will not be located at higher elevations.

8 UNCERTAINTIES

8.1 Introduction

This section is presented in accordance with the Ministry of Natural Resources Technical Guidelines for EIAs. The technical guideline requires an uncertainties section to :

- outline information or data gaps about any particular aspect of the receiving environment that was unable to be collected, and any attempts to gather the information.
- provide an explanation should the attempts to get the information were not successful.
- outline instances where the specific activities or technologies to be applied during the Project are unknown at the time of report preparation and the most probable methods to be adopted and a prediction of the impacts based on that method.

Predictions of project potential impacts may be assessed using tools ranging from quantitative techniques such as air emissions modelling or noise modelling (as was the case in this environmental and social impact assessment, ESIA) to qualitative techniques based on expert judgment and historical information. The accuracy of these assessment tools depends on the quality of the input data and available information. The nature of any uncertainties associated with assumptions that are made during the course of impact assessment are discussed with the client. For qualitative predictions/assessments, some uncertainty may sometimes be reduced or eliminated through stakeholder consultation.

Environmental and social risk can be difficult to predict with certainty when the design process is in progress, as is the case for the KM250A Project. This ESIA was developed post-front end engineering and design stage, and thus relied on access to basis of design and basic engineering data and information, uncertainty stemming from ongoing development of the Project design is inevitable. Furthermore, the environmental and social context of the Project site varies from season to season and year to year. Where these uncertainties are critical to interpretation of ESIA findings, they must be clearly stated and approached conservatively ('the precautionary approach') in order to identify the broadest range of likely residual impacts and necessary mitigation measures. This section of the report highlights the uncertainties related to the KM250A Project ESIA.

The objectives of this section are to provide details on uncertainties encountered with respect to this ESIA, and to provide clarification on methods used to reduce those uncertainties, and how the results should be interpreted in light of remaining uncertainties.

This ESIA was prepared based on findings of desktop research (previous field surveys conducted by others), and various field surveys conducted by RSK to fill gaps in the desktop research. Field surveys to inform the impact assessment were undertaken from August through November 2019. Predictive models were undertaken for air quality and noise in order to establish possible concentration of air contaminants and high levels of noise at sensitive receptors within the respective Project AOIs. Details are discussed in the following sections.

8.1 Key uncertainties

8.1.1 Lender requirements

The KM250A Project initiated funding discussions with the Overseas Private Investment Corporation (OPIC) in 2019. In January 2020, OPIC was restructured and is now operating as U.S. International Development Finance Corporation (DFC). DFC combines OPIC and the U.S. Development Credit Authority. It is assumed that DFC will have similar lender requirements as OPIC, however, at the time of writing, this has not been ascertained. It is assumed that this ESIA is compliant with DFC environmental and social requirements for lending.

8.1.2 Stakeholder engagement

Stakeholder engagement at the community level was undertaken in October 2019. Further stakeholder engagement will be undertaken during the disclosure phase of the ESIA regarding the outcome of the ESIA. This ESIA will be updated following disclosure to incorporate the inputs from the future stakeholder engagement activities.

Stakeholder engagement findings are based on focus group discussions, key informant interviews and household surveys. Each person or group of persons was selected to ensure that they adequately represented their respective population categories. However, there is some level of uncertainty in access to stakeholders to ensure that the groups or persons consulted represent the full range of Project-affected people and that their views are adequately taken into account in the impact assessment process.

Through on-going engagements with stakeholders at the community level via Pearl Petroleum's Social Performance Department (SPD) and external community Grievance Management Procedure (Figure 4-9), Pearl Petroleum will ensure adequate consideration of stakeholder concerns with respect to the KM250A Project will be ensured.

8.1.3 Baseline socio-economic conditions

The following challenges were encountered and managed during the gathering of primary and secondary social baseline data for the ESIA:

- The last census was held in Iraq in 1997 and did not include the Kurdistan Region of Iraq (KRI); in the absence of a formal census, secondary data from trustworthy sources (e.g. KRG ministries and international organisations such as the World Bank) have been utilised.
- As of March 2014, the KRI comprises four governorates (see Section 3.4.3 on administrative structure and governance). The most recently established governorate – Halabja – was previously part of the Governorate of Sulaymaniyah. Secondary data on Halabja is often subsumed within data on Sulaymaniyah at the governorate level and therefore it is not always possible to differentiate between the two. Disaggregated data on Halabja has been provided as far as possible.
- Data provided by informants may be affected by translation from Kurdish to English; triangulation has been used to reduce this data risk.

- Data on the incidence of Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS), mental health issues, social ills, gender-based violence (GBV) and female genital mutilation (FGM) were difficult to obtain at the local level. This may be attributed to a number of reasons, including the potentially sensitive nature of the topics.
- Data on annual income and expenditure were difficult to obtain at the local level with 70% of households interviewed being unwilling to disclose information. This may be attributed to several reasons including:
  - lack of knowledge about income earnings and money spent by households
  - fear that levels of income and expenditure will influence households' eligibility for employment opportunities and/or other benefits associated with the existing facility
  - concerns about pride in the case of low-income households.
- Data were collected in each Project-affected community (PAC) in accordance with Table 3-30. However, the village Anjuman of Aliawa declined to participate in an interview at the time of the social baseline surveys. To manage this problem, data provided by the village Anjuman of the remaining PACs have been relied upon. Approximately 95% of the village Anjuman who were targeted participated in key informant interviews; the data gathered from these leaders is considered to be valid across the AOI.
- As outlined in Section 3.4.1.2, 145 household interviews were conducted during the surveys, representing 80% of households in the primary sphere of influence. It was not possible to interview every household as some households are only living in some of the PACs part-time and were not present at the time of the social baseline surveys (see Section 3.4.4). To manage this problem, data provided by the village Anjuman have been relied upon. Village Anjuman have extensive knowledge and a comprehensive understanding of their communities and the households within them. As such, the data provided by these leaders and the 80% of households who were interviewed is considered sufficiently robust to develop the socio-economic baseline.

Though these challenges have been managed as far as possible, they create uncertainties regarding baseline socio-economic conditions in the AOI. The inability to obtain primary data on sensitive topics such as income levels and health issues (e.g. HIV and AIDS, GBV and FGM) limits the level of understanding that has been developed in relation to these topics at the local level. Moreover, the inability to interview every household in PACs belonging to the primary sphere of influence (e.g. because they were not present at the time of primary baseline data collection) means that it has not been possible to establish a completely representative sample of households in these PACs.

8.1.4 Air quality

Various previous studies contained information on field surveys undertaken in the Project area. However, methodologies used to collect air quality data contained in previous studies were not verifiable. Furthermore, the placement of air monitoring stations in those studies was not always suitable in terms of the KM250A Project. Furthermore, the sampling points used in previous studies did not include all sensitive receptors within the KM250A Project air quality AOI. A one-month air quality monitoring programme was therefore implemented to gather accurate information on current air quality baseline conditions at locations that suited the requirements of the KM250A Project ESIA.

Therefore, to reduce uncertainties and to gather information on current air quality baseline conditions in the air quality AOI, a one month air quality field survey via passive diffusion tubes (as described in Section 3.2.6.4) was undertaken in September 2019 at eight sampling stations. The sampling locations were chosen to represent as best as possible the sensitive receptors within the air quality AOI, as well as upstream and downstream air quality. The diffusion tubes were sent to a laboratory in the UK for analysis. This resulted in reliable and up-to-date baseline data for air quality within the AOI. The results of this field survey were used to establish the air quality baseline and to support the prediction of Project impacts on air quality.

Taking three to four weeks of data ensured that daily variations would not unduly affect the results. Nonetheless, the air quality data collected was limited in that it represents only one month, and thus do not represent baseline conditions in the AOI throughout the entire year, during which weather and meteorological conditions are likely to change.

Air emissions modelling (see Section 5.7.1.3.3) was undertaken to predict the impact of emissions during the operating phase of the KM250A Project on air quality at sensitive receptors within the air quality AOI. The input data for the model was based on best engineering judgement and assumptions regarding plant design characteristics that have not yet been finalised, including stack or flare exit velocity, height and diameter, and, for non-routine flaring, the likely flaring scenarios. Nonetheless the input data set is considered conservative.

8.1.5 Soil and water resources

Soil quality sampling and analysis was undertaken previously at well sites (MapCom, 2018). However, no soil samples were taken within the KM site fenceline. Therefore, as part of this ESIA, soil samples were taken at key locations at the KM250A Project site within the soil AOI (that is, physical footprint of the Project, reflecting the expected disturbance of soil within newly developed areas of the main site). Samples were taken for future reference at the main Project site in areas where hazardous materials or waste will be stored when Project operations begin.

Sampling of streams, springs and groundwater within the water resources AOI was undertaken to reduce uncertainty associated with previous water sampling results (Section 3.2.4.3) in terms of location and sampling and analysis methodology. The results considerably strengthen AOI baseline data.

Best engineering judgement was combined with existing geological and groundwater quality data to assess expected impacts of KM250A Project water consumption on the local groundwater aquifer. This approach was necessarily qualitative as very little data was available concerning groundwater level, flow and recharge. Recommendations were developed regarding long-term monitoring of groundwater resources that will allow Pearl Petroleum to accurately monitor the impacts of water abstraction by Pearl Petroleum as water demand at the site increases with the KM250A Project and future expansion at the Khor Mor site and thus reduce future uncertainties regarding sustainability of local groundwater resources.

8.1.6 Noise

Previous noise measurements were not suitable for the current ESIA as they were restricted to well pad locations. No noise measurements had been taken at the Khor Mor site fenceline nor at sensitive receptors (villages) outside of the Khor Mor site fenceline. In August 2019, RSK measured baseline noise at various locations within the noise AOI at sensitive receptors. Noise measurement and analysis was conducted following British Standards. Noise measuring equipment was calibrated as required by those standards. Noise measurements were taken over 24 hours at some monitoring points and for 30 minutes at others, according to the nature of the location (see Section 3.2.5.3).

Like air quality, noise levels may change over the course of a year. This may add some uncertainty to the results.

As for air emissions modelling, various assumptions have been made to inform the construction phase noise assessment, such as the type of plant being used, the number of plant items operating, the running time throughout the day, the contractor's working hours etc. This was largely based on front end engineering design information received from Pearl Petroleum. As mentioned earlier, this has inherent uncertainty, as the Project design is in an early stage of development. If the final construction or plant equipment selection, procedures or working arrangements differ significantly from the assumptions that have been made, it may be necessary to re-visit the assessment. Furthermore, at this stage in the KM250A Project, vendor datasheets are not available for certain plant installations. In the absence of vendor/measurement data, it is assumed that the noise emissions from the proposed plant items will not exceed a level of 85 dB(A) at 1 m. For the flare, it has been assumed that the sound power level will not exceed 133 dB(A). To reduce future uncertainty regarding the results of this ESIA, vendor and additional noise measurement data should be obtained for all installations, sufficient to validate or modify the predicted noise levels.

Other assumptions made in respect of the proposed plant installations include dimensional data, height of the source emissions above ground level and the source directivity. Together, the assumptions were conservative and therefore will reduce uncertainties regarding the modelling results by generating a worst-case scenario.

8.1.7 Biodiversity/ecology

Previous ESIAs and baseline studies associated with this site were consulted to determine whether additional field survey was necessary (see Section 0), and if so, the necessary scope of those surveys. Previous studies were found not to be representative of the KM250A Project biodiversity and ecology AOI.

The ecological field survey conducted in October 2019 within the Khor Mor fenceline, just outside of the Khor Mor site fenceline, and along the RoWs for the new flowlines. Given the limited time period of the survey, it may not have provided a detailed record of the species present throughout the year, as some species of flora may not be flowering, making identification more difficult, and some fauna species may be absent from the site during the survey period. Nonetheless, this survey provided an overview of species presence and an understanding of the habitats within the Project area rather than a detailed ecological baseline. However, the use of already existing biodiversity information at Khor Mor, online resources, grey literature and an understanding of the habitats on-site that complemented the field survey meant that assumptions could be drawn regarding the likely species present throughout the year (especially regarding birds and other migratory species) without positive identifications during the field surveys. This significantly reduced the uncertainty associated with development of the biodiversity/ecology baseline.

8.1.8 Cultural heritage

Previous studies identified several possible archaeological sites of interest outside of the Khor Mor site fenceline within the cultural heritage AOI (see Section 3.4.12). One of these sites was in the approximate area of the RoW of one of the proposed KM250A Project flowlines. Uncertainty exists regarding the possible presence of other archaeological sites of interest in the area of the new flowlines, and concerning the nature and value of the identified site. A walkover by a team archaeologist was implemented in the area of the planned flowlines and information was gathered during the stakeholder engagement interviews from local communities. There was no further evidence of possible archaeological sites at grade. Uncertainty will be further mitigated through the use of a chance finds procedures during flowline construction.

8.2 Conclusions

The impact assessment presented in this report was based on assumptions that were conservative but in keeping with both good international industry practice and Ministry of Natural Resources guidelines. Where necessary, field surveys were undertaken to ensure that available data reflected an accurate view of existing baseline conditions. As the period of field surveys was limited to the period August through November 2019, supplemental data was used to ensure reasonably sound knowledge of baseline information throughout the year. Conservative assumptions were made regarding Project design data and information to account for any future changes as the design process evolves. Taken together, the above measures ensure that uncertainties associated with the conclusions of this ESIA (largely the environmental and social risks estimated via qualitative or quantitative impact assessment, and the mitigation measures proposed for reducing the significance of significant impacts) are considered sound and reliable as a basis for decisions related to the Project.

9 RELEVANT INTERNATIONAL AND DOMESTIC REGULATIONS

9.1 Introduction

This section provides a high-level description of the current regulatory framework associated with the KM250A Project and provides current information relating to the following:

- Iraq's ratification of pertinent international conventions
- national legislation that applies to the Project
- Kurdish institutions involved in environmental management
- Project Standards
- lender requirements.

9.2 International conventions and agreements

Iraq has signed, ratified or acceded to international conventions and agreements, including those listed in Table 9-1, which are relevant to the Project. These include social conventions that aim to protect universal human rights and the rights of vulnerable groups and protect intangible cultures and cultural heritage sites of particular importance. They include agreements that set standards for employment and health.

Various environmental conventions concern the use, emission or trans-boundary movement of certain types of substances, for example, the Montreal Protocol prohibits ozone-depleting chemicals. Some conventions identify specific international targets, for example, the 2015 Paris Agreement stipulates that countries will determine the reduction in greenhouse gas emissions necessary to limit global temperature increases. Other environmental conventions aim to protect sensitive habitats, such as wetlands or drylands or promote initiatives to designated areas for the protection of biodiversity.

Table 9-1 International conventions signed/ratified by Iraq

International convention	Date	Iraq status
Social, health and cultural heritage		
Universal Declaration of Human Rights	1948	Signed, 1948
International Convention on Economic, Social and Cultural Rights	1969	Ratified, 1971 (see note)
Core conventions of the ILO: C182: Elimination of the Worst Form of Child Labour C138: Minimum Age Convention C100: Equal Remuneration C29: Forced Labour C98: Right to Organised and Collective Bargaining C111: Discrimination, Employment and Occupation	-	 Ratified, 2001 Ratified, 1985 Ratified, 1963 Ratified, 1962 Ratified, 1962 Ratified, 1959

International convention	Date	Iraq status
Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property	1970	Accepted, 1973
Paris Convention on the Protection of World Cultural and Natural Heritage	1972	Acceded, 1974
Convention for the Safeguarding of the Intangible Cultural Heritage	2003	Ratified, 2010
International Health Regulations	2005	Ratified, 2007
Environment		
Ramsar Convention	1971	Acceded, 2007
UN Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1975	Acceded 2014
Vienna Convention for the Protection of the Ozone Layer	1985	Acceded, 2008
Montreal Protocol	1987	Acceded, 2008
Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal	1989	Acceded, 2011
UN Framework Convention on Climate Change and Kyoto Protocol	1992	Signed, 2009
Rio de Janeiro Convention on Biological Diversity	1992	Acceded, 2009
Bonn Convention on Combating Desertification	1994	Acceded, 2010
UN Convention to Combat Desertification	1996	Ratified, 2010
The Paris Agreement	2015	Signed, 2016

Note: Except for the First and Second Protocols

9.3 Iraq federal and regional legal system

The Iraq constitution (October 2005) allows for semi-autonomous administrative regions. A region may have its own constitution and exercise legislative, executive and judicial authority over itself to the extent that these powers do not conflict with federal authority. The Kurdistan Region of Iraq (KRI) is recognised as a semi-autonomous region of Iraq under the 2005 constitution with its own regional government. The Kurdistan Regional Government (KRG) is the official ruling body of the KRI and is democratically elected to exercise executive power according to the laws of the Kurdistan region, as enacted by the Kurdistan Parliament.

Under the constitution, the federal authorities have exclusive powers over a wide range of matters (such as foreign policy, national security, policies relating to water sources from outside Iraq), but the constitution has included provisions for shared responsibility between the federal authorities and the administrative regions for the management and development of oil and gas resources and the following areas:

- regulation and distribution of the main sources of energy
- environmental policy
- development and general policy
- public health
- education
- policy and organisation of the main internal water sources to guarantee fair distribution.

In general terms, if an Iraqi (federal) law was passed before 1991[28] then it applies to Kurdistan. On matters where there is no equivalent Kurdish law, then the relevant post-1991 Iraqi legislation applies. Where an Iraqi law that applies to the Kurdistan region conflicts with a Kurdish law, the Kurdish law takes precedence. However, if the law relates to an area within federal jurisdiction as defined by the Iraqi constitution, then federal Iraqi law applies.

9.4 Kurdistan Region of Iraq institutional framework

The institutional framework and regulatory agencies responsible for overseeing the oil and gas activities within the KRI are:

- Kurdistan parliament (legislative body of the KRI and passes its laws)
- KRG governs KRI in accordance with laws enacted by the Kurdistan parliament
- Regional Council formulates the general principles of petroleum policy, prospect planning, field developments and approves petroleum contracts
- Environmental Protection and Improvement Board oversees environmental matters
- The Ministry of Natural Resources (MNR) oversees and regulates all petroleum operations in the KRI on behalf of the KRG, jointly with the Prime Minister (representing the Regional Council).

Other agencies and ministries such as the Directorate of Labour and Social Security, the Directorate of Residency and the Ministry of Agriculture and Water Resources have regulatory oversight for their areas of competence, which include activities of international oil companies operating in the KRI.

9.5 Environmental legislation in Kurdistan

Environmental law in Kurdistan (and throughout Iraq) is in an evolutionary phase. The reconstruction and development of the region is the driving force behind clarifying and strengthening environmental, safety and social governance.

[28] Following the First Gulf War Iraqi forces finally left Kurdistan in October 1991, leaving the region with *de facto autonomy*. Hence, Kurdish laws as such were created and enforced past that date, and are recognised in Kurdistan as the only applicable laws.

The applicable legislation consists of either laws (local and federal) or instructions. A law is a binding legislative act and it must be applied in its entirety across the KRI. The details for implementing the laws are usually explained by instructions. The instructions clarify or amend existing legislative provisions included in the laws and the guidelines, and contain additional guidance and information.

9.5.1 Environmental protection improvement and environmental impact assessment requirements

The legal framework for the protection of the environment in Kurdistan is currently provided for by the Law of 2008 'Environmental Protection and Improvement in Iraqi Kurdistan Region' (Law number (8) of 2008). In 2010, an independent Environmental Protection and Improvement Board was established in KRI by Law of Environmental Protection and Improvement Board (Law number (3) of 2010). Law number (3) of 2010 defines the Environmental Protection and Improvement Board structure and members and defines the Board's responsibilities.

Where environmental standards for environmental media such as air, noise or water are not provided within the Kurdistan Law number (8) of 2008, standards within the equivalent Iraqi laws are considered applicable in Kurdistan; these are specified in Section 9.7.

Law number (8) of (2008) provides the directions for:

- the establishment of the regional environmental protection and improvement council and regional governorates
- the establishment of an environmental fund for financing environmental protection and improvement programs, conservation programs and to achieve the goals of the law (fund is partly made up of fines and duties levied according to this law)
- the inspection of institutions, projects and activities by the environmental observation teams of the MNR to monitor legal compliance
- the evaluation of environmental impacts and the issuing of environmental certificates of acceptance (details provided below)
- the assignment of responsibility for environmental pollution and compensation of damages
- the protection of water, air and soil as well as the improvement, conservation of biodiversity, recycling of waste and dangerous substances, although no threshold limits for emissions, discharges or volumes are stated in the legislation
- the use of pesticides and chemical compounds
- the management of large-scale environmental incidents (disasters)
- the provision for stopping work, withdrawing environmental consent, fines and punishment.

Chapter 5 of the Law sets out the requirements for the evaluation of potential environmental impacts and issuing environmental consents. An environmental impact assessment (EIA) must be carried out for any project or activity with a potential environmental impact.

In February 2015, in reliance upon the powers conferred by Article 53 and Article 60 of the Oil and Gas Law number (22) of 2007, MNR issued 'Instruction number (1) of 2015 on the EIA of Petroleum Operations' that became effective from April 2015. The instructions set out the requirements and processes of the MNR for the EIA for petroleum operations and it defines the entities to which the instructions apply. It states that submission of an acceptable EIA to MNR is a prerequisite for operation.

During March 2015, technical guidelines on EIAs for petroleum operations in the KRI were issued by the Health, Safety and Environment Department of MNR to provide additional guidance and information on the requirements in the instructions. Chapter 4 of the Guidelines provides details of the EIA report content, and in Chapter 5 the EIA submission and review process is explained.

This ESIA report (which also includes social impact assessment) will follow the content outline as described in the technical guidelines on EIAs for petroleum operations in the KRI (Chapter 4). The approval process for EIAs is depicted in Figure 9-1.

Article 12 of Kurdistan Law number (8) of 2008 sets out broad guidelines for the minimum requirements of an EIA. These include:

- evaluation of the positive and negative effects of the project on the environment
- definition of the proposed approach to preventing and mitigating causes of pollution in a way that achieves compliance with the environmental regulations and regulatory requirements
- identification of the risks of an environmental emergency arising from the project and actions to be taken
- identification of alternative technologies that may be utilised that are environmentally cleaner and that would better preserve natural resources
- identification of means to decrease waste and means to recycle waste products from the project
- estimation of the value of any environmental benefits and the costs of environmental damage that the project may produce.

The EIA should be submitted to MNR for their evaluation and final decision. MNR may impose conditions on the environmental consent. Under Article 15, related agencies must work in coordination with MNR in approving environmental consents for projects and reporting back to MNR on their compliance with any consent conditions.

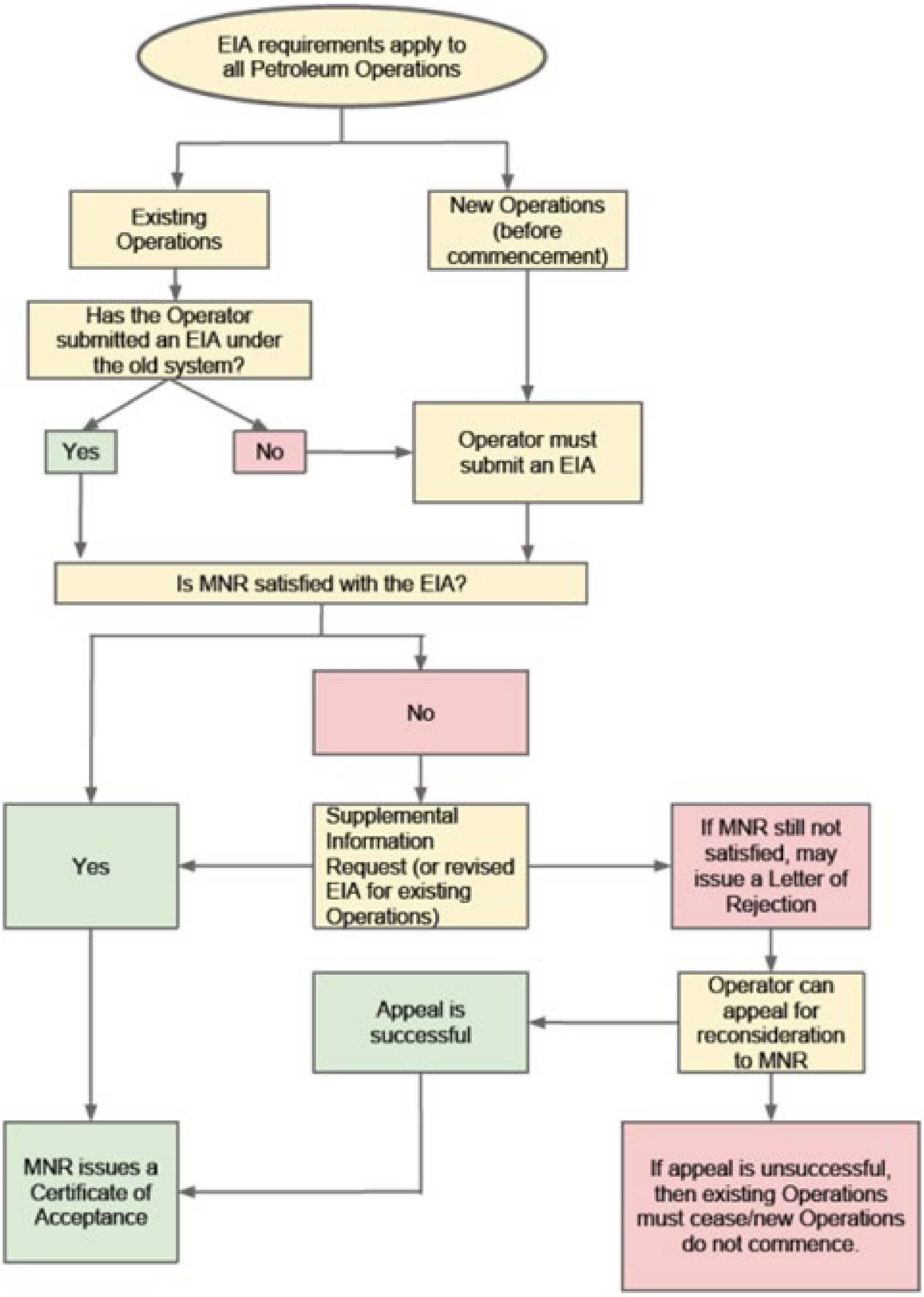

Figure 9-1 MNR submission and review process

9.5.2 Legal basis for categorisation of projects and environmental conditions

9.5.2.1 Siting

The Iraqi Law regulating mineral investment Number (91) of 1988 provides that the following areas cannot be allocated as land for mineral investment:

1. Areas that include a sacred site, public cemetery or is located less than 500 m of it, unless granted approval by related authorities for that site. Every religious place or building supervised by a recognised religious body shall be considered a sacred site.
2. Areas that contain or are located within less than 500 m of a historical site, according to provisions of the Archaeology Law, unless granted approval by the competent authorities.
3. Lands containing agricultural projects, forests, dam and reservoir sites, tunnels and main streams connected to them, unless granted approval by the competent authorities, taking into consideration the stipulated conditions for the protection of agricultural products and compensation for damages incurred.
4. Lands located within and outside municipal boundaries of cities.
5. Land dedicated to or maintained for the following:
    - railway with a distance less than 500 m from each side
    - main road with a distance less than 1000 m from each side
    - bridges with a distance less than 1500 m from them excluding what have been approved by the competent authorities
    - land which belongs to military authorities or which has special military importance, only upon approval of the military authorities
    - oil and gas fields and lands by less than 500 m from oil pipelines, oil products and gas, unless granted approval by the competent authorities
    - factories sites, departments, socialist sector, mixed and private sectors, unless granted approval of the competent authorities
    - land that is less than 1000 m from electric transmission lines, unless granted approval of the competent authorities
    - land which is less than 500 m from coaxial cable lines by, unless granted approval of the competent authorities.

Article 11 under Chapter 4 of Kurdish Law number (8) of 2008, Environmental Classification and Requirements for Project Development, provides for planning at the regional level.

9.5.2.2 Noise

Article 27/2 of Kurdish Law number (8) of 2008 concerns the permissible levels for noise. Instruction number (1) of 2011 for noise reduction in the KRI contains the following provisions:

- Article 1:
    - 4 - Noise is defined as sounds annoying human and animals when heard, due to the high and variable frequency, and it consists of three types: external noise, internal noise and back noise.
    - 6 - Unacceptable noise is defined as the undesirable sound which disturbs mind and mood or raises nerves and exceeds 85 dB on daytime and 70 dB night-time.
    - 9 - The standard for the level of noise at the workplace is the constant (continuous) noise allowed at the working site is 85 dB.
    - 10 - The change rate is defined as the level of noise that exceeds the standard level that will require a decrease in worker exposure.

- 17 - Rest times are from 11pm to 6 am and from 3 pm to 6 pm in summer, and from 10 pm to 7 am and from 2 pm to 5 pm in winter.

- Article 2 holds that the environmental departments receive citizen's complaints related to noise (emitted from buildings, vehicles, or machines or equipment on roads or from persons or any other sources that cause disturbance). After a finding that the noise is unacceptable, the complaint will be submitted to the Provincial Council, to give an opinion.
- Article 5:
  - Sounds exceeding 70 dB are considered harmful to human health, and it is advised not to be exposed to such noises.
  - Exposure of human ears to sound intensity exceeding 65 dB are considered to have a negative impact on the quality of life.
  - Sound intensity exceeding 60 dB are considered as noise.
- Article 7 holds that the maximum exposure to noises for residents of surrounding areas for all projects is 60 dB in daytime and 55 dB in night-time.

The acceptable limit of noise for construction activities is defined in this instruction (see Table 9-2). Table 9-3 defines maximum allowable noise in the workplace.

Table 9-2 Acceptable limit of noise for construction activities

Industrial areas	Trade areas	Residential areas	Schedule
85 dBA	80 dBA	75 dBA	Daily: from 7am to 7 pm
70 dBA	65 dBA	60 dBA	Daily: from 7pm to 7am

Table 9-3 Sound intensity inside the workplace and indoor places

Determination the type of place and activity	Maximum acceptable noise intensity equivalent dB
1. Workplaces with night shift until 8 hours	85
2. Workplaces that require hearing of acoustic signs and good speech hearing	80
3. Workrooms to follow up, measure and set up operation	65
4. Workrooms of computer units or typing machines or similar to that	70
5. Workrooms of activities that require routine mental focus	60

9.5.2.3 Air

Based on the provisions of Article (10), Law number (3) of 2010 and provisions of the both Articles 26 and 27/1 of Law number (8) of 2008, Instruction number (2) of 2011 was issued.

- Article 3: The sources of common air pollutants including those concerning oil storage are to be identified and concerned parties shall provide the Environmental Protection and Improvement Board in the KRI with concentrations of each pollutant with annual emissions.
- Article 4: The national standard for each level of the common pollutants is issued by the Environmental Protection and Improvement Board in the KRI.

- Article 6: It is prohibited to use machinery, equipment, vehicles, engines and generators that produce air pollutants exceeding the acceptable limits.
- Article 7: Environmental Protection and Improvement Board in the KRI specialises, in coordination with the relevant ministries, to prepare the information system related to air quality in KRI. All private and public concerned persons should:
    - supply the Environmental Protection and Improvement Board in the KRI with all data and available information in their records
    - submit data and information of the numbers and nature of storages containing hazardous materials and chemicals that impact the atmosphere and public health.
- Article 8: Parties that cause air pollution from their activities must:
    - submit an environmental impact statement before commencing the establishment. Including the procedures for ambient air quality protection
    - inform the Environmental Protection and Improvement Board in the KRI of methods and systems used for mitigating air pollution and for fixing potential defects
    - have measuring devices and monitor the main air pollutant. Results of measurements should be provided to the Environmental Protection and Improvement Board in the KRI
    - establish and maintain a database in terms of air quality protection.
- Article 9: the owner of the development project should submit an EIA statement before commencement that includes the following:
    - evaluation of positive and negative impacts of the project on air quality
    - suggestions of methods to reduce and address the causes of air pollution to achieve compliance with the instructions
    - potential air pollution and the precautions needed to be taken
    - possible alternatives to use environmentally cleaner techniques to reduce air pollution.

9.5.3 Oil and Gas Law

The Oil and Gas Law of the KRI (Law number (22) of 2007) applies to petroleum operations within KRI. The Law establishes the public entities responsible for the control and management of exploration, production sharing and development of resources.

Articles that specifically refer to environmental protection or stipulate environmental requirements are summarised below:

- Articles 25 and 26 on the granting of an Access Authorisation, particularly Article 26 (3rd) (2) where the Access Authorisation shall include conditions for protecting the environment, preventing, reducing and remedying pollution and other environmental harm from petroleum operations, securing the health, safety and welfare of persons involved in or affected by the petroleum operations, giving preference in employment in the petroleum operations to citizens of the KRI and other citizens of Iraq and the acquisition of goods and services from persons based in the KRI and other parts of Iraq.

- Article 36 (1st): decommissioning the contract area at the end of the period of authorisation or when no longer used for petroleum operations.
- Article 53 (13th) specifies that the Access Authorisation holder shall report on compliance with obligations set out in the authorisation relating to protection and restoration of the environment.

9.5.4 Petroleum Development Agreement

In 2007 the KRG signed a Petroleum Development Agreement with Pearl Petroleum to provide gas supplies for use at the power stations that were then under construction at Erbil and Chemchemal and also to appraise the Khor Mor field.

Pearl Petroleum submitted a Field Development Plan (FDP) to MNR following the Declaration of Commerciality. The MNR requires that FDPs enclose a Local Development Plan which should incorporate:

- a workforce development plan, which includes workforce planning, recruitment and retention plans, localisation, competency development and management, industry collaboration, outreach, local leadership and management development, and technology transfer
- a local enterprise development plan, which includes local supply and services status, local supply and contracting strategy, local enterprise development, and local supplier and services standards
- a community development plan, which includes community engagement, community impact assessment, community employment and community investment.

9.5.5 Investment law

KRI Law number (4) of 2006 is applicable to any economic activity or investment project set up by a natural or artificial person on an allocated plot of land, and with a national or foreign capital to which the provisions of this Law and relevant regulations and directives apply. Under article 8, clause 5 of the Law all investors shall safeguard the environment, maintain public health and safety, and comply with standardisation and quality control systems, in accordance with international standards.

9.6 Land and property legislation in Iraq and Kurdistan

At the Iraqi national level, several laws contain provisions relevant to land, including:

- the Constitution[29]
- the Civil Code of 1951[30]
- Resolution No. 333 Promulgating Law No. 42 of 1987[31]

[29] The Iraqi constitution attempts to strike a balance between needs of the individual and those of the state and protects *tasarruf* rights holders (who comprise approximately 70% of all land in Iraq) from expropriation without compensation (World Bank, 2016b).

[30] The Civil Code stipulates how property rights such as *tasarruf* are regulated, and a couple of important aspects of *tasarruf* are worth noting. A person in possession of *miri* land is entitled to *tasarruf* rights, which can be used as security for a loan. However, if a *tasarruf* holder leaves land unused for three years without cause, rights to the land are forfeited. With the death of a *tasarruf* holder, the rights are passed to the deceased's heirs. If the heirs do not accept the *tasarruf,* it is then auctioned off (World Bank, 2016b).

[31] The law is focused on the reorganisation of land ownership for lands subject to agricultural projects. It also provides remedies for compensation to land owners for expropriation (USAID, 2019a).

- Resolution No. 176 Promulgating Law No. 18 of 1993 Relative to the Body of Administration and Investment of Awaqf Properties[32]
- Iraqi Company for Contracts for Land Reclamation (Law No. 116 of 1981)[33]
- the Agrarian Reform Law No. 117 of 1970[34]
- Law No. 02 of 1983 on Pasture[35]
- Resolution No. 150 of 12 October 1997 Concerning the Sale of Plots of Land for Housing Owned by the State to Farmers[36].

At the KRG level, several region-specific laws contain provisions relevant to land,

- Resolution Relative to Corporeal Compensation for Appropriated Real Estates and Amortisation of the Right of Disposal of Vacant Agricultural Reform Lands, No 90. of 1996[37]
- Resolution to Prevent Alienating of Estate Property of Iraqi Citizens Who Left Iraq, No. 21 of 1996[38]
- Resolution Concerning Agricultural Land, Unofficial Title, No. 211 of 1991[39].

9.7 Selection of Project Standards

The environmental instructions set locally by the Environmental Protection and Improvement Board are enforced in the KRI, focusing on different environmental conditions and allowable limits of pollutants in various aspects of the environment, including air and noise instructions. Where environmental standards are not available in

[32] The resolution establishes the 'Body of Administration and Investment of Awaqf Properties' that is legally, financially and administratively independent, but connected with the Ministry of Awaqf and Religious Affairs. The body administers and develops land and property received as an endowment and acts as a council for all issues in terms of the administration and investment in Awaqf (also known as waqf) properties. The body is managed by a council comprising the Minister, several experts, three lawyers and officials from government (USAID, 2019a).

[33] The law establishes the Iraqi 'Company for Contracts of Land Reclamation' under the Council of Ministers. The Company implements reclamation projects and acts as a contractor for reclamation projects. The Company is charged with carrying out its duties both inside and outside Iraq. The Company can sell and lease reclaimed lands and the properties of the company are considered 'state domains' (USAID, 2019a).

[34] This law covers a variety of agricultural land ownership issues, including the maximum size limit of lands that can be owned privately without authorisation. The Agrarian Reform Authority can requisition lands above the stated limit and stipulate the forms of compensation that the owner of the requisitioned excess land is due. The Authority takes over the responsibilities of the survey committees regarding lands not yet surveyed, and those lands against which survey decisions are still pending. The Authority will distribute agrarian reform lands to peasants both individually and collectively (USAID, 2019a).

[35] This law intends to manage pasture lands by planning grazing according to scientific approaches, and engaging in the protection of natural vegetation and water resources and the organisation of their use. The Law covers state-owned lands allocated for pasture. The Law states that the Ministry of Agriculture and Agrarian Reform is to regulate and organise livestock movements according to seasons and regions. The law prohibits the drilling of artesian wells and cutting plants in pasture lands (USAID, 2019a).

[36] The Resolution stipulates that state-owned land not burdened by 'disposal rights' shall be sold to farmers, and pre-existing agricultural contracts are revoked and pre- existing rights extinguished. The Resolution provides limits of the allocation to farmers — not more than 1,000 m^2 with no house and 2,000 m^2 for a plot with a house (USAID, 2019a).

[37] This law provides for compensation for the alienation of agricultural land, with alternative land as a first priority and cash compensation as a secondary priority. The law also prohibits compensation in-kind or cash for certain types of land (USAID, 2019a).

[38] The resolution stipulates that the transfer of real estate owned by Iraqi citizens who left the country is to be prevented in all cases (USAID, 2019a).

[39] The resolution stipulates that agricultural lands owned by the state, which are cultivated by persons themselves or through others, shall be considered as property of the state with no compensation due, and shall be registered in the name of the Ministry of Finance as 'pure' property. The Ministry of Agriculture shall dispose of such lands in accordance with laws and regulations in force (USAID, 2019a).

the Kurdistan legislation, the equivalent standards set up in Iraqi federal laws are applicable in Kurdistan (for example for water quality).

The KM250A Project Standards were selected from KRI, Government of Iraq (GoI) and relevant international standards including the World Bank Group/International Finance Corporation (IFC) standards and World Health Organisation (WHO) standards. The most stringent applicable standards were selected as the Project Standard. A summary of the applicable standards and the selected Project Standard is provided in Appendix 3.

9.7.1 Soil quality standards

A summary of the applicable soil quality standards and the selected Project Standard is presented in Appendix 3 (Table A3.1).

There are no published KRI standards for soils. The Iraq Ministry of Oil adopts Australian generic assessment criteria for inorganic (metal compounds) and organic compounds (such as chlorinated hydrocarbons, polychlorinated biphenyls, various hydrocarbons fractions, phenols, polycyclic aromatic hydrocarbons) by land use (for the health investigation levels):

- A - Standard residential with garden/accessible soil (home-grown produce contributing less than 10% of vegetable and fruit intake; no poultry): this category includes children's day-care centres, kindergartens, preschools and primary schools
- B - Residential with minimal opportunities for soil access: it includes dwellings with fully and permanently paved yard space such as high-rise apartments and flats
- C - Parks, recreational open space and playing fields: it includes secondary schools
- D - Commercial/Industrial: includes premises such as shops and offices as well as factories and industrial sites.

The Australian guidelines also include soil assessment levels for ecological investigation levels that are intended for urban areas and may not be sufficiently protective where areas of high ecological value (such as national parks and nature reserves) are involved.

Additionally, the Iraq Ministry of Oil has adopted Dutch guidelines for concentrations of the zinc, lead and the hydrocarbon fraction C10 –C40. These guidelines represent the Tier 1 screening (maximum concentration and intervention values).

9.7.2 Water quality standards

A summary of the applicable water quality standards and the selected Project Standard is presented in Appendix 3 (Table A3.2 and A3.3).

In the absence of water quality standards in the Kurdistan Law number (8) of 2008, the following Iraqi standards apply for the Project:

- Regulation number (25) of 1967 'Protection of Rivers and Public Water from Pollution' sets quality standards for surface water in bodies including canals and for groundwater in wells and establishes methods to prevent the excessive use of the available water resources (Appendix 3, Table A3.2).
- Regulation number (2) of 2001 'Protection of Water Resources' sets standards for the discharge of wastewater into water sources and is regulating the

utilisation of water for purposes other than domestic use (Appendix 3, Table A3.2).

- Standard Specification number (417) of 2001 for potable drinking water issued by Iraq's Central Agency for Meteorology and Quality Control (Appendix 3, Table A3.3).

9.7.3 Noise standards

A summary of the applicable noise standards and the selected Project Standard is presented in Appendix 3 (Table A3.4 and A3.5).

Instruction number (1) of 2011 for noise reductions in Kurdistan region establishes the limits for daytime, evening time and night-time exposure in residential and trade areas, and it sets higher limits for industrial areas. These standards take account of annoyance, as well as health factors and exposure period.

Daytime and night-time periods are defined as 07:00-22:00 and 22:00-07:00 respectively by the IFC however, KRG guidelines include evening and night-time periods. The stricter time period comes from KRG legislation and shall therefore be the selected Project Standard.

The relevant KRG legislation also outlines acceptable noise level limits for construction activities. These are assessed against the noise requirements as per the GoI and IFC in Appendix 3 (Table A3.5).

9.7.4 Air quality standards

A summary of the applicable air quality standards and the selected Project Standard is presented in Appendix 3 (Table A3.6 to Table A3.8).

The Project air quality standards were selected following review of KRG ambient air quality standards, Government of Iraq (GoI) standards, and IFC EHS requirements. In general, the most severe of the three was selected as the Project Standard, following best international practice. Air emissions modelling results were tailored to accommodate the standards for facilitating comparison. For example, modelling outputs were generated for short-term ground level concentrations (1-hour, 3-hour or 24-hour standards) or long-term (annual) ground level concentrations. The results of the air quality passive diffusion tube field survey were converted to an annual basis to allow comparison to annual standards.

The GoI ambient air quality standard for SO_2 at an averaging period of 1-hour is stricter than the KRG's standard at an averaging period of 3-hours. It is standard practice for ambient air quality standards to be less strict at shorter averaging periods. Therefore, the GoI standard for SO_2 at an averaging period of 1-hour is set as the Project Standard for both 1-hour and 3-hours.

The World Health Organisation (WHO, 2005) ambient air quality guidelines (adopted by IFC, 2007) interim limit 1, which is similar to the KRG standard will also be considered.

9.8 Requirements for Project financing

9.8.1 International Finance Corporation Performance Standards

Pearl Petroleum is committed to providing compliance with the pertinent national environmental legislation and international lending requirements of the International Finance Corporation (IFC) Performance Standards (PSs) on Social and Environmental Sustainability (2012) and Environmental, Health and Safety (EHS) Guidelines of the World Bank Group. Meeting these standards will also meet International lender requirements. The PSs are designed to help avoid, mitigate, and manage environmental, health, safety and social risks and impacts and include stakeholder engagement and disclosure obligations of the client in relation to project level activities. The IFC requires its clients to carry out an ESIA in accordance with PS1 and additional PSs 2-8 as applicable (see Table 9-4):

Table 9-4 Overview of IFC PSs

IFC PS	Key points relevant to the Project
PS1: Assessment and Management of Environmental and Social Risks and Impacts	PS1 underscores the importance of managing social and environmental performance throughout the life of a project by using a dynamic social and environmental management system. Specific objectives of this PS are: • 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 Project has committed to abiding by PS1, including full consultation with local communities and setting up mechanisms for working with Affected Communities.

IFC PS	Key points relevant to the Project
PS2: Labour and Working Conditions	The requirements set out in this PS have been in part guided by a number of international conventions negotiated through the International Labour Organization (ILO) and the United Nations (UN). Specific objectives of PS2 are: • to establish, maintain and improve the worker-management relationship • to promote the fair treatment, non-discrimination and equal opportunity of workers and compliance with national labour and employment laws • to protect the workforce by addressing child labour and forced labour • to promote safe and healthy working conditions, and to protect and promote the health of workers. The Project will need to ensure that it upholds labour rights and provide safe working conditions during both construction and operation .
PS3: Resource Efficiency and Pollution Prevention	PS3 outlines a project approach to pollution prevention and abatement in line with international available technologies and practices. It promotes the private sector's ability to integrate such technologies and practices as far as their use is technically and financially feasible and cost-effective in the context of a project that relies on commercially available skills and resources. Specific objectives of PS3 are: • to avoid or minimise adverse impacts on human health and the environment by avoiding or minimising pollution from project activities • to promote the reduction of emissions that contribute to climate change. Consideration of resource efficiency and pollution prevention have been made during project planning. The findings of the ESIA will further advise the design of the Project.
PS4: Community Health, Safety and Security	This PS recognises that project activities, equipment, and infrastructure often bring benefits to communities including employment, services, and opportunities for economic development. However, projects can also increase risks arising from accidents, releases of hazardous materials, 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 PS addresses the project sponsor's responsibility in respect of community health, safety and security. The ESIA process will include the production of Environmental and Social Management Plans which will feed into the construction and operational Management Systems. These plans and procedures to include community health, safety and security plans.

IFC PS	Key points relevant to the Project
PS5: Land Acquisition and Involuntary Resettlement	Involuntary resettlement refers both to physical and economic displacement as a result of project-related land acquisition. Where involuntary resettlement is unavoidable, appropriate measures to mitigate adverse impacts on displaced persons and host communities should be carefully planned and implemented. No physical displacement will be required during the KM250A Project. No additional land- take is required at the gas plant. Future land use surveys will determine whether any economic displacement will result from land- take at the wells and flowlines.
PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	This Performance Standard reflects the objectives of the Convention on Biological Diversity to conserve biological diversity and promote the use of renewable natural resources in a sustainable manner. This Performance Standard addresses how project sponsors can avoid or mitigate threats to biodiversity arising from their operations as well as sustainably manage renewable natural resources. Specific objectives of this Performance Standard are: • to protect and conserve biodiversity • to promote the sustainable management and use of natural resources through the adoption of practices that integrate conservation needs and development priorities. A critical habitat screening assessment and field surveys have been conducted.
PS7: Indigenous Peoples	Performance Standard 7 recognises that Indigenous Peoples, as social groups with identities that are distinct from dominant groups in national societies. There are no known Indigenous Peoples within the Study Area. PS7 will be followed should any indigenous or minority groups be found to be present in the area during baseline survey work although this is considered unlikely.
PS8: Cultural Heritage	Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this Performance Standard aims to protect irreplaceable cultural heritage and to guide project sponsors on protecting cultural heritage in the course of their business operations. The ESIA baseline surveys included walkover surveys and discussions during stakeholder consultation. Should any sites of cultural heritage be identified, PS8 will be followed.

9.8.2 International Finance Corporation Environmental, Health and Safety guidelines

The IFC EHS guidelines are a series of technical reference documents with general and industry specific examples of good international industry practice (GIIP). When host country regulations are missing or differ from the levels and measures presented in the EHS guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines 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 should demonstrate that the choice for any alternate performance levels is protective of human health and the environment. Applicable World Bank Group/IFC Guidelines are included in Table 9-5.

Table 9-5 Applicable IFC/World Bank EHS guidelines

IFC guideline	Content
Policy on environmental and social sustainability (January 2012)	IFC commitments to environmental and social sustainability and PS 1 – 8
EHS Guidelines for Onshore Oil and Gas Development (April 2007)	Technical reference document that addresses onshore oil and gas exploration and production operations.
General EHS Guideline 1.1 Air Emissions and Ambient Air Quality (April 2007)	Provides an approach to the management of significant sources of emissions, including specific guidance for assessment and monitoring of impacts. It provides additional information on approaches to emissions management in projects located in areas of poor air quality.
General EHS Guideline 1.2 Energy Conservation (April 2007)	Provides information about common techniques for energy conservation.
General EHS Guideline 1.3 Wastewater and Ambient Water Quality (April 2007)	Provides information on common techniques for wastewater management, water conservation, and reuse.
General EHS Guideline 1.4 Water Conservation (April 2007)	Water conservation programs and measures.
General EHS Guideline 1.5 Hazardous Materials Management (April 2007)	Hazardous materials management to avoid or, when avoidance is not feasible, minimise uncontrolled releases of hazardous materials or accidents (including explosion and fire) during their production, handling, storage and use.
General EHS Guideline 1.6 Waste Management (April 2007)	Principles for general waste management as well as specific guidance for dealing with hazardous waste.

IFC guideline	Content
General EHS Guideline 1.7 Noise (April 2007)	Addresses impacts of noise beyond the site boundary including prevention and control, noise level guidelines for different receptors; and monitoring.
General EHS Guideline 1.8 Contaminated Land (April 2007)	Management approaches to land contamination due to anthropogenic releases of hazardous materials, wastes, or oil, including naturally occurring substances.
General EHS Guideline 3.0 Community Health and Safety (April 2007)	These address project activities taking place outside of the traditional project boundaries, but nonetheless related to the project operations, including: Water Quality and Availability, Traffic Safety, 3.5 Transport of Hazardous Materials, 3.6 Disease Prevention, 3.7 Emergency Preparedness and Response
General EHS Guideline 4.0 Construction and Decommissioning (April 2007)	These outline 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 or due to expansion or modification of existing project facilities. The environment section (4.1) includes topics such as noise and vibration, soil erosion, air quality, solid waste, hazardous materials, wastewater discharges and contaminated land. The community health and safety section (4.3) includes topics such as general site hazardous, disease prevention and traffic safety.

9.8.3 U.S. International Development Finance Corporation

The KM250A Project initiated funding discussions with the Overseas Private Investment Corporation (OPIC) in 2019. In January 2020, OPIC was restructured and is now operating as U.S. International Development Finance Corporation (DFC). DFC combines OPIC and the U.S. Development Credit Authority. Preliminary information suggests that DFC will have similar lender requirements as OPIC. DFC applicants should be guided by World Bank Group/IFC PSs (see Section 9.8.1), industry sector guidelines, internationally recognised worker rights, and host country laws, regulations and standards related to environmental and social performance, including host country obligations under international law.

The requirement to meet the Project-specific performance requirements extends to on-site contractors and sub-contractors that work for a substantial duration of time on the Project or are material to the primary operations of the Project. Applicants are responsible for ensuring that on-site contractors and sub-contractors meet the performance requirements.

For existing projects (for example privatisation projects), the performance requirements must be attained within a reasonable period following the receipt of DFC support, except for labour rights requirements, which must be met from the outset. If material compliance has not been demonstrated at the time of DFC approval, applicants are required to prepare and implement a corrective action or remediation plan demonstrating how compliance with the Project-specific requirements will be achieved within the specified time period. Remediation plans for Category A projects[40] are subject to public disclosure and third-party audits.

Applicants seeking DFC support must demonstrate compliance with host country environmental, health, safety and social requirements. Where host country requirements differ from the PSs, industry sector guidelines, and internationally recognised worker rights, the Project is expected to meet whichever is more stringent.

[40] OPIC defines Category A projects as those 'Business activities with potential significant adverse environmental or social risks and/or impacts that are diverse, irreversible, or unprecedented.'

10 ENVIRONMENTAL AND SOCIAL MANAGEMENT

10.1 Introduction

This section details the framework for the management of health, safety, security, environmental (HSSE) and social performance (SP) issues associated with the KM250A Project and describes the key elements that form the health, safety, security, environmental and social management framework that will apply to the KM250A Project, including:

- Pearl Petroleum HSSE and SP policy and management system (MS) framework
- Pearl Petroleum HSSE&SP standards
- Pearl Petroleum KM250A Project HSSE&SP Management Plan (MP)

The latter complies with Kurdistan Region of Iraq (KRI) Ministry of Natural Resources (MNR) and International Finance Corporation (IFC) Performance Standard 1 requirements for the environmental and social management plan. Details concerning the safeguards, measures and plans that constitute the Pearl Petroleum KM250A Project HSSE&SP MP ('KM250A HSSE&SP MP') are provided in Section 11.

Details are provided regarding the following essential mechanisms embedded in the KM250A HSSE&SP MP for implementing the same:

- roles and responsibilities
- communications
- management of change.

The Pearl Petroleum KM250A HSSE&SP MP will extend through all phases of the KM250A Project and is intended to inform Pearl Petroleum and contractor personnel (including the construction phase engineering, procurement and construction, EPC, Contractor) of their roles and responsibilities in delivering the Project in compliance with Pearl Petroleum HSSE&SP standards. As per the Field Development Plan (FDP) (Pearl Petroleum 2018), the development of specific HSSE&SP requirements will occur in a phased manner consistent with the requirements for the respective phases.

Figure 10-1 below illustrates the application of the Pearl Petroleum HSSE&SP MS, spanning the transition from the current system used in the existing operation, through to the Pearl Petroleum HSSE&SP MS, which will be the basis for the KM250A HSSE&SP MP for the KM250A Project and future expansion projects.

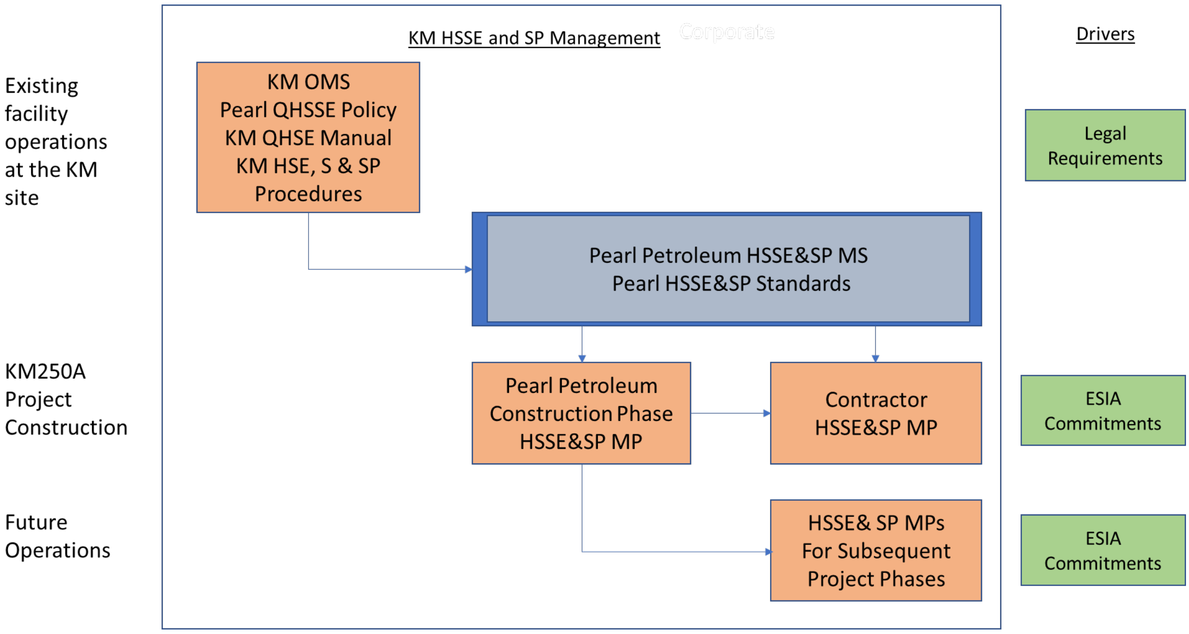

Figure 10-1 KM environmental and social framework

10.2 Pearl Petroleum HSSE&SP MS

As per Figure 10-1, the Pearl Petroleum HSSE&SP MS establishes the framework and standards for the KM250A Project, incorporating where appropriate existing HSSE&SP requirements established in the current operations.

The Pearl Petroleum HSSE&SP MS has been developed considering national environmental and social requirements of the KRI, recognised health and safety and environmental management standards such as Occupational Health and Safety Assessment Series 18001, International Standards Organisation (ISO) 14001, and international standards such as the IFC environmental and social requirements (especially the IFC Performance Standards and the IFC Environmental Health and Safety standards).

Section 9 describes the KRI legal framework, key legislative requirements and international guidelines and standards that will be applicable to the KM250A Project. Pearl Petroleum (and any contractor) shall be responsible for identifying and obtaining all necessary permits for activities within their scope of work.

Compliance with the Pearl Petroleum HSSE&SP MS will be monitored during all phases of the KM250A Project. Audit and assurance activities will be established to provide feedback regarding the effectiveness of systems, processes and controls.

Overall details on the Pearl Petroleum HSSE&SP MS and further details on the SP Standard are provided in the following sections.

10.2.1 Pearl Petroleum HSSE&SP requirements

As described in the FDP Pearl Petroleum requires that HSSE&SP is an integral part of all phases of Project execution. The selected concept, design and work programme will demonstrate that risks are managed to levels deemed as low as reasonably practicable (ALARP).

HSSE&SP considerations will include prevention of personal injury, occupational illness, major accidents, property damage and environmental and social impact due to activities associated with the Project. This will require rigorous identification of hazards, thorough analysis of risks, and development of effective risk controls.

The Pearl Petroleum HSSE&SP MS framework is structured in three levels as defined below and illustrated in Figure 10-2:

- **Level 1**: HSSE&SP Policy and HSSE&SP MS Framework and Standard Elements
- **Level 2**: HSSE&SP Standards – standard procedures that collectively cover all activities
- **Level 3**: Local HSSE&SP procedures and supporting tools – asset/location/project specific procedures, site work instructions and guidance.

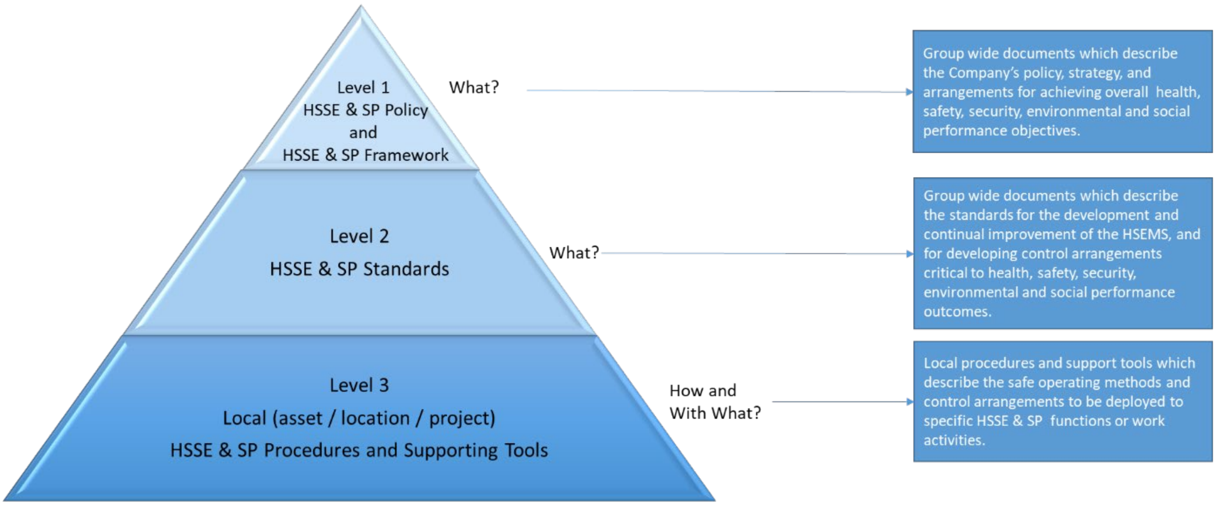

Figure 10-2 HSSE mangement structure

10.2.2 HSSE&SP Policy, Standards and Procedures

Specific corporate standards are listed in Figure 10-3. HSSE&SP Policy, HSSE&SP MS Framework and Standards are outlined in Table 10-1. These provide the framework and requirements for KM250A Project specific HSSE&SP procedures. Human Rights Policy and Code of Conduct (to manage potential human rights issues associated with the KM250A Project) and Human Resources Policy (to manage labour and working conditions and includes an internal worker grievance mechanism; already being applied at the existing KM site) will be incorporated within the KM250A Project HSSE&SP MP.

Figure 10-3 Corporate standard elements

Table 10-1 HSSE&SP policy, standards, procedures and supporting tools

Level	Item	Description	Status
HSSE&SP Policies and Framework			
1	HSSE&SP Policy	Details the HSSE&SP principles and expectations for doing business in an environmentally and socially responsible manner	Current operations are conducted under the Crescent QHSE Policy. A revised integrated HSSE&SP Policy has been established for the KM250A Project and future operations
	HSSE&SP Management System Framework and Standard Elements	The 16 Standard Elements (Figure 10-3) set out the management measures required to reduce the potential health, safety security, environmental and social impacts, and to enhance the benefits of the proposed Project activities	Developed and in process of implementation.
HSSE&SP Standards			
2	HSSE Leadership OHS Management	HSSE&SP Standards to support the HSSE&SP Policy and Management System Framework.	HSSE&SP Standards are the major part of the HSSE&SP MS development and enhancement programme and will be applied to

Level	Item	Description	Status
	Plant Integrity	These standards apply to all Pearl Petroleum assets and locations and may be supplemented by local Level 3 instructions or guidance	the KM250A Project. HSSE&SP standards ensure consistency of performance across the organisation and standardise requirements.
	Security Management		
	Environmental Management		
	Social Performance		
	Hazard Identification, Risk, Assessment and Control		
	Management of Change		
	Personnel Training and Competence		
	Communication and Promotion		
	Documentation and Information Management		
	Contractor Management and Purchasing		
	Emergency Preparedness and Response		
	Incident Management		
	Performance Monitoring and Performance		
	Periodic Review and Improvement		
Asset/Location/Project-Specific HSSE&SP Procedures*			
3	Projects	Project Specific HSSE&SP Procedures and supporting tools provide additional direction and guidance on how to implement best practice at project locations. Examples are as follows: • Project HSSE&SP Plans • EPC Contractor HSSE&SP Plan • HSSE&SP Bridging	Development in progress to fit Project Schedule and activity plan. Alignment and Bridged with EPC Contractor and interface with existing operations.

Level	Item	Description	Status
		• Land Access Procedure • Chance Finds Procedures • Grievance Management Procedure	
	Operations	Operations Specific HSSE&SP Procedures and supporting tools provide additional direction and guidance on how to implement best practice at asset locations. Examples are: • Location Emergency Response Plan • Permit to Work Procedure • Local Waste Management Plan	A full suite of operational HSSE&SP documents are developed and implemented into Kurdistan (Khor Mor) existing operations.
	Drilling	Drilling Specific HSSE&SP Procedures and supporting tools provide additional direction and guidance on how to implement best practice at asset locations. Examples are: • Drill-site Emergency Response Plan • Blowout Contingency Plan • Well-site Waste Management Plan	Drilling specific documents detailing minimum HSSE&SP requirements to be adhered to by Drilling and Workover Contractors. Implemented in current Kurdistan Drilling Operations.

* Developed specifically to align to asset locations and activities e.g. operations, projects, drilling

Pearl Petroleum seeks to develop strong, mutually beneficial relationships with the communities and other stakeholders wherever it operates, contributing to economic and social development. Essential to this is understanding and minimising any adverse social and human rights impacts which may result from its activities. The SP Standard sets out the basic framework for implementing Pearl Petroleum's HSSE&SP Policy. The SP Standard is supported by a set of related Operating Procedures and Guidelines designed to assist with implementation.

Specifically, Pearl Petroleum will:

- Comply with applicable environmental and social laws, regulations and obligations and, where these do not exist adopt and apply standards that are in alignment with the intent of its Policy and international good practice.
- Allocate resources commensurate to social risks, potential impacts and socio-economic opportunities to ensure appropriate implementation of social performance management plans throughout the project lifecycle.
- Ensure appropriate governance and management systems are in place to identify, measure, manage, monitor and oversee its social performance.
- Embed social performance across the organisation through a culture of shared responsibility and accountability which integrates social performance considerations into business decision making.
- Include appropriate social performance requirements in contractual agreements when significant potential adverse social impacts and/or opportunities to deliver socio-economic development exist.

- Regularly monitor and evaluate social performance activities and capabilities to ensure compliance with its Policy and to facilitate continuous improvement.

Within the SP functional remit are the following key areas:

- social impact assessment, mitigation planning and implementation;
- land access and compensation;
- local stakeholder engagement and community consultation; and
- social investment.

The main elements of the SP Standard are presented schematically in Figure 10-4.

Figure 10-4 Structure of Pearl Petroleum SP Standard

10.3 KM250A HSSE&SP MP

The KM250A HSSE&SP MP is aligned with the Pearl Petroleum HSSE&SP MS. The key objectives of the KM250A HSSE&SP MP include:

- achieve intended environmental and social management outcomes and mitigate the KM250A Project's identified environmental and social impacts to the levels predicted in the ESIA
- describe the requirements that shall be met to ensure that the commitments made in the ESIA for the Project are fully implemented
- provide a mechanism to achieve compliance with legal obligations and demonstrate conformance with the corporate environmental and social policies and standards (see Section 10.2)
- provide a mechanism to monitor the effectiveness of the mitigation measures employed
- provide a framework to manage HSSE and SP risks during the construction stage of the Project to conform with applicable policies, regulations and standards and ensure that Project HSSE&SP commitments are attained.

The KM250A HSSE&SP MP is considered a "live" document that can evolve during the life time of the Project consistent with a continual improvement approach (as defined by ISO 14001).

The management of Project HSSE&SP risks will follow a 'cascade' approach, reflecting good international practice as follows:

- The guiding management plans are outlined in the KM250A HSSE&SP MP and are derived from related policies and standards (*cf.* the HSSE&SP MS).
- Contractors must develop their own KM250A HSSE&SP MP (to be approved by Pearl Petroleum).
- Contractors must implement and enforce the KM250A HSSE&SP MP measures in their own activities and those of any of their sub-contractors and other service providers.
- Contractors will undertake periodic monitoring of the performance of HSSE&SP MP implementation (and report to Pearl Petroleum).
- Pearl Petroleum conducts its own overall monitoring of contractor performance (and reports to lenders).
- Lenders and external advisors conduct independent audits.

Pearl Petroleum and any contractor will develop KM250A HSSE&SP MPs that reflect their work activities and responsibilities to comply with Pearl Petroleum HSSE and SP requirements. The KM250A HSSE&SP MPs will incorporate topic-specific management plans that propose mitigation and control measures to address the Pearl Petroleum HSSE&SP MS requirements and ESIA commitments.

Contractors shall develop and implement a process for identifying and maintaining a list of applicable regulations, permits, codes and work place standards and practices. Contractors shall submit data as necessary to the regulator as per the licence or consent conditions and shall maintain copies of all permits and authorisations in English and Kurdish. Monitoring will be carried out to evaluate the effectiveness of mitigation measures, action plans and corrective actions. Inspection and audits will be conducted to assess compliance to regulations, corporate standards, and obligations.

MNR ESIA guidelines and KRI legal requirements call for a review of the performance of the KM250A HSSE&SP MP every six months. Updates and revisions to the HSSE&SP MP will be implemented as appropriate to reflect the findings of monitoring, inspections and audits, as well as to accommodate any new mitigation required and to reflect lessons-learned from the monitoring.

The Project HSSE&P MP will subsequently be updated and revised as appropriate for each phase of the Project to reflect the different HSSE&SP risks at that stage and any lessons learned to date. The operations phase KM250A HSSE&SP MP, which will support development of HSSE&SP related operational management plans and procedures not currently in place, will be drafted during the end of the construction stage and disclosed not later than six months before the start of KM250A Project commercial operations.

The Commitments Register (Appendix 8) documents all commitments that have been made in the ESIA in relation to the various KM250A Project phases and includes mitigation measures, management and monitoring activities.

The ESIA Commitments Register has been developed to provide:

- a description of the commitment made in the ESIA
- the Project stage(s) to which the respective commitment is applicable
- responsibility for implementation.

10.4 Roles and Responsibilities

10.4.1 Globally at Pearl Petroleum

All Pearl Petroleum employees shall:

- be aware of and demonstrate HSSE&SP commitment through their actions
- perform job functions in a manner which prevents accidents, eliminates harm to people and does not damage the environment
- actively participate in HSSE&SP meetings
- STOP WORK THAT IS UNSAFE.

In addition to the above, Line Managers shall:

- be a visible proactive leader of HSSE&SP and assist in implementation of the HSSE&SP MS
- ensure that resources are in place to execute an effective HSSE&SP MS
- ensure that Project, contractor and supplier facilities, and locations are in alignment with the HSSE&SP goals of the Project
- evaluate and select contractors who adhere to the high HSSE&SP expectations of the Project.

The Project HSSE and SP team shall:

- lead co-ordination with other HSSE and SP teams
- lead co-ordination on environmental permitting and other studies
- maintain Project records and documentation
- compile Project scorecard data (key performance indicators, KPIs) and other summary data
- monitor and assign responsibility for completion of HSSE&SP action items included in an action tracker
- conduct management and provide technical oversight for Project's contractors.

Site Project HSSE and SP teams will be responsible for the safe and efficient implementation of Project activities in full compliance with the KM250A Project HSSE&SP MP.

10.4.2 Current Pearl Petroleum HSSE and SP teams

The KM250A Project Director holds overall accountability for HSSE&SP performance of the Project, alongside and integral to all other aspects of KM250A Project delivery. The Corporate Head of HSSE and the KM250A Project HSE Manager are accountable to the Project Director for ensuring that systems are established, implemented and maintained to ensure delivery of required performance and management of risk. HSSE performance requirements will be clearly assigned and visible within Pearl Petroleum's management team members holding specific HSSE responsibilities in their areas of accountability.

Key HSSE&SP team positions and responsibilities in relation to the KM250A Project are as follows:

- Corporate Head of HSSE: Provides strategic HSSE direction and governance to all areas of Pearl Petroleum. Designs, manages and implements all environmental, health and safety policies for Pearl Petroleum. Provides technical expertise and directions on all issues relating to HSSE matters for the entire company. Maintains a high level of HSSE knowledge and awareness in order to promote a safe working environment. Reports to the Executive Director, Projects. Based in Sharjah.
- Project HSE Manager: Provides the support necessary to contribute towards efficient health, safety and environmental management in order to create secure, safe and healthy working conditions throughout the KM500 construction site, while protecting the environment during the Project execution phase. Reports to the Construction Manager. Based at KM site.
- Regional Senior HSSE Manager: The role provides HSSE functional leadership and assurance regarding all in-country activities undertaken by Pearl Petroleum,. Manages the relationship with the regulator, ensuring that all activities undertaken meet regulatory requirements, and that the regulator remains aware of and engaged with Pearl Petroleum forward plans. Responsible for building the organisational capability and culture, such that HSSE considerations become an integral part of all site activities. The Senior HSSE Manager provides high-quality coaching and development, effective communications into the organisation, and builds the functional capability within the functional team. Based in Erbil.
- Social Performance Manager: In cooperation with Pearl Petroleum Field SP Managers, the SP Manager manages and oversees all SP activity in Kurdistan and coordinates SP activities in support of exploration, appraisal, capital project and production operations activities, as well as supporting and inputting to early development planning for the business. The role primarily engages key stakeholders to secure broad-based support for activity and manage social risks associated with managing all Field resources and work program. The position is also responsible for ensuring that host communities and the region benefit from the presence of SP activities. The SP manager is responsible for developing and implementing Pearl Petroleum's Framework and strategy in the areas of SP grievance management and community relations. In consultation with Kurdistan Field SP Manager, the Social SP Manager formulates short and long-term SP objectives, KPI's and plans, ensuring they benefit the local communities as well as the company's objectives. The SP Manager works closely with the line management and HSSE managers and Asset Protection functions as well as HR.
- Social Performance Field Manager: The SP Field Manager oversees and coordinates all field-based SP activities in support of exploration, appraisal, capital projects and production operations activities, as well as supporting and inputting to early development planning for the business. The SP Field Manager engages with host communities and other key stakeholders to secure broad-based support for activity and manage social risks associated with managing all field resources and work program. The SP Field Manager is also responsible for ensuring that host communities and the region benefit from the presence of SP activities. The SP Field Manager is the lead expert in field implementation of the Pearl Petroleum's strategy in the areas of SP (including impact assessment and management, community and stakeholder relations, land access and social investment). In consultation with the Kurdistan Social Performance Manager, this expert formulates and implements a social

investment programme that meets both business objectives and ensures that neighbouring communities benefit on an enduring basis.

10.4.3 Contractors

Contractors' roles and responsibilities for compliance with environmental and social requirements are reflected in relevant contractor performance guidelines and HSSE&SP exhibits to their contracts. The contractors shall ensure as minimum the following:

- strict adherence to relevant laws, regulation and guidelines
- providing all workers with written contracts describing their rights under national labour law
- providing appropriate on-the-job training to enable local employees to improve their skills whilst working on the Project
- planning of each task to include documented safety, environmental and social risk identification and assessment
- applying appropriate control measures to reduce safety risks, environmental impacts and social disturbance
- monitoring parameters agreed with Pearl Petroleum and providing all monitoring results
- communicating HSSE&SP incidents to Pearl Petroleum and rectifying immediately
- attending meetings and workshops as directed.

During operations, the Operations Manager is responsible for ensuring conformity with HSSE&SP requirements as detailed in the HSSE&SP MS and the Project HSSE&SP MP. The on-site supervisors and personnel will monitor key environmental and social performance indicators to ensure targets are met. They will monitor effectiveness of the mitigation measures and report the performance to the senior management and to the government agencies, as required.

The operations phase contractors will also be required to demonstrate how they will comply with all relevant legislation and industry good practice, and how they will implement the proposed mitigation measures. The contractors will monitor environmental and social performance to evaluate actual performance against its objectives.

10.5 Communication

10.5.1 Internal communications

Relevant issues are communicated to all Project employees who are encouraged to provide feedback on all such issues. Internal communication takes the form of formal and informal mechanisms including:

- weekly HSSE and SP meetings
- HSSE and SP notice boards
- distribution to managers/supervisors by e-mail for broadcast
- HSSE and SP toolbox talks.

The Project HSSE and SP Managers are responsible for convening and chairing weekly meetings of their respective teams and shall be also responsible for posting relevant information on communication channels.

In addition to the formal capture of issues and concerns at structured meetings, internal communications may be received as: e-mails from staff, letters from staff and internal phone calls from staff that require a written response. An internal grievance procedure is in place for the workforce.

10.5.2 External communications and stakeholder engagement principles

Pearl Petroleum maintains proactive and open engagement with local communities and other stakeholders via external communication and engagement activities as outlined in the Pearl Petroleum SP Standard. The objectives of external communication and stakeholder engagement are to build positive relationships with neighbouring communities and contribute to a secure operating environment. Frequent meetings are held between Pearl Petroleum and local communities, coordinated through and with the village leaders (Anjuman). These communication and engagement platforms will be used to provide local residents with Project updates and address questions related to Pearl Petroleum and contractors' activities.

All external communications and engagement activities shall be referred to and conducted by Pearl Petroleum's Social Performance Department (SPD). Pearl Petroleum's SPD calls for maintaining communications with community stakeholders, particularly Project-affected communities, during all phases of the KM250A Project.

A number of mitigation measures identified during the ESIA requires Project information to be made accessible and available to local communities and other interested stakeholders. This is being addressed by Pearl Petroleum based on the Stakeholder Engagement Plan (SEP) for the ESIA phase (see Section 4).

The community Grievance Management Procedure ensures that stakeholders have an easy means of lodging any grievances related to the KM250A Project and ESIA (Section 4.6).

All external HSSE communications are documented in the communications register recording the following:

- date of communication
- name of the person
- contact details (i.e. telephone number and e-mail)
- how the communication was received (i.e. letter, e-mail or phone call)
- nature of the communication (e.g. request for information, complaint, concern)
- brief details of the response.

10.6 Management of Change

Changes to the Project may occur subsequent to preparation and submission of this ESIA. A Management of Change Procedure will be implemented, that includes:

- environmental and social appraisal of the change
- health and safety evaluation
- consultation with engineering and HSSE&SP disciplines
- consulting MNR on the need for amendments to the ESIA permit
- subject to MNR direction, undertaking environmental and social evaluation of the change

- identifying new or revised mitigation measures
- identifying changes to the KM250A HSSE&SP MP and supporting management plans.

The Project HSSE&SP MP will be based on a four-step iterative process aligned with the Plan-Do-Check-Act model as represented in Figure 10-5. The concept reflects an adaptive management loop allowing for accommodation of changes that occur as the Project moves through the various implementation stages.

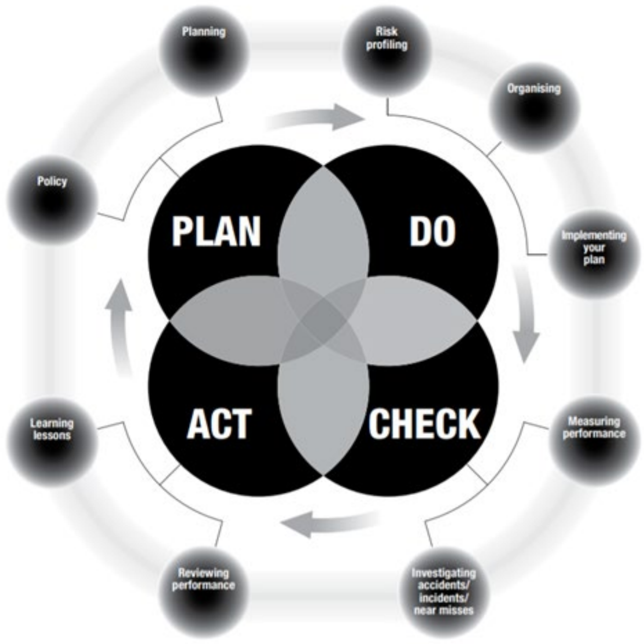

Figure 10-5 Plan-do-act-check methodology

11 SAFEGUARDS, MEASURES AND PLANS

11.1 Introduction

This section provides details of the existing and future safeguards, measures and plans that will be applied during implementation of the KM250A Project in order to reduce or eliminate potential impacts that have been identified during the environmental and social impact assessment (ESIA) process. These safeguards, measures and plans sit within the overall framework of the Pearl Petroleum Health, Safety, Security, Environmental and Social Performance (HSSE&SP) Management Plan (MP) as described in Section 10, which is in turn aligned to the Pearl Petroleum HSSE&SP Management System (MS).

11.2 General approach

The approach to environmental and social management for the KM250A Project is presented below. Selected proposed safeguards, measures and plans for each phase are further described in the subsequent sections. Existing plans and procedures are available from Pearl Petroleum.

The KM250A HSSE&SP MP will evolve with each Project phase. A construction phase HSSE&SP MP will first be developed prior to the start of that phase. Six months prior to the commissioning and operations phase of the Project, the KM250A HSSE&SP MP will be adapted to KM250A operations to meet the requirements of that phase of the Project. Finally, prior to decommissioning, the KM250A HSSE&SP MP will be adapted to this final phase of the Project. Further details of this approach are provided in the following sections.

The KM250A Project HSSE&SP MP and supporting documentation for the construction and pre-commissioning phases will describe HSSE and social management during that phase of the Project, will detail both Pearl Petroleum and contractor responsibilities, and will reflect construction commitments made in the ESIA (Kurdistan Region of Iraq and Iraqi legal requirements and good international industry practice, GIIP). Relevant documents that already exist and are already being applied at the existing operation will be signposted in the construction phase KM250A HSSE&SP MP.

Some of the existing HSSE&SP documents may need to be enhanced in order to incorporate relevant KM250A Project commitments; these enhancements will also be applicable in the operations phase, as appropriate. Any requirements that are applicable only to the Project construction phase will be detailed only in the construction phase KM250A HSSE&SP MP and supporting documentation. The construction phase KM250A HSSE&SP MP and supporting documentation will describe how the requirements of the Pearl Petroleum HSSE&SP MS will be applied specifically during the construction phase of the Project.

The construction phase engineering, procurement and construction (EPC) Contractor (and any contractors hired independently of the EPC Contractor) will be required to develop their own KM250A HSSE&SP MP and supporting documentation that bridges the requirements in line with the KM250A HSSE&SP MP and supporting documentation. HSSE&SP requirements for contractors will be included the KM250A HSSE&SP exhibits to the contracts. Sub-contractors will be required to comply with contractor HSSE&SP

MPs and will be monitored on the same basis by the main contractors and by Pearl Petroleum.

The KM250A HSSE&SP MP, including the safeguards, measures and plans developed for construction phase activities will be enhanced and adapted to ensure that any operational commitments made in the ESIA, legal requirements, and GIIP are incorporated.

A separate set of environmental and social documentation will be developed to address the environmental and social impacts present during decommissioning. As possible, the decommissioning phase KM250A HSSE&SP MP will be based on the construction phase and operations phase versions of the KM250A HSSE&SP MP.

Details of the contents of the KM250A HSSE&SP MP for each phase of the KM250A Project are provided in the following sections.

11.3 Construction phase

The construction phase KM250A HSSE&SP MP will include, but may not be limited to, the following:

- reference to Project legal and other requirements including the commitments register
- Project policies
- health, safety, security, environmental and social organisation, including:
- definition of interfaces between Pearl Petroleum and contractors
- roles and responsibilities of all concerned personnel
- Pearl Petroleum and contactor HSSE&SP MP and related documentation
- key performance indicators (KPIs)
- environmental and social management measures and crisis and continuity management, emergency response and incident reporting (see Text Box 11.1)
- information management and document control
- monitoring, checking and corrective action including monitoring, compliance assurance and auditing, non-compliance reporting, corrective and preventative action
- HSSE&SP processes for review and management of change.

Textbox 11.1 provides a list of key existing plans and procedures that will be incorporated into the KM250A HSSE&SP MP. Some of these existing plans and procedures may need to be adapted to the KM250A Project. The KM250A HSSE&SP MP will be the basis for the contractor KM250A HSSE&SP MP.

Within the framework of the existing SP Standard, Pearl Petroleum will develop and implement a comprehensive construction phase Social Monitoring Plan that includes monitoring socio-economic changes in local communities (e.g. in living standards, household well-being and access to food and other daily necessities) through regular community meetings and through regular price surveys.

Text Box 11.1

Existing Plans and Procedures

- Recruitment Strategy
- Capacity Building and Skills Development Programme (including Occupational Health and Safety Training Programme
- Training and Capacity-building Plan
- Worker and Security Code of Conduct
- Worker Grievance Management Procedure
- HSE Plan and related procedures
- Stakeholder Engagement Plan (SEP)
- Community Grievance Management Procedure
- Chance Finds Procedure
- Waste Management Procedure
- Emergency Response Plan
- Spill Prevention and Response Procedure
- Fire Department Standard Operating Procedure

The construction phase contractor(s) will also be expected to develop the following:

- Gender Inclusion Strategy, which will provide for assessment of the potential risks that may be associated with women's participation in the KM250A Project will be assessed
- Community Health, Safety and Security Plan
- Local Goods and Services Plan (including Local Community Employment Plans and Retrenchment Plans), to ensure maximum use of local goods and services (including labour)
- Dust Management Plan, allowing for dust suppression by spraying water onto dirt tracks and flowline RoWs
- Lighting Plan, that will include minimisation to the extent possible of impacts on nearby sensitive receptors (villages and habitats)
- Retrenchment Plan with the aim of ensuring social cohesion and reducing the impacts of the termination of employment contracts. The overall approach will be aligned with IFC guidelines on retrenchment.
- Health and Safety Plan(s) and Work Management Procedure(s); these will be approved by Pearl Petroleum and will be aligned with Pearl Petroleum's overarching health and safety systems and international standards. Auditing will be undertaken by Pearl Petroleum to ensure contractor compliance with health and safety plans and work management procedures.
- Where appropriate, each construction contractor will develop a work-specific Traffic Management Plan (TMP) which identifies sensitive social receptors along transportation routes and outline mitigation measures (e.g. speed limit restrictions, vehicle maintenance activities, awareness campaigns, recruitment of traffic wardens) to reduce the risk of road traffic accidents occurring.

Although much of the KM250A HSSE&SP MP will be based on existing plans and procedures, various new plans will need to be developed by Pearl Petroleum. Summaries of the contents of key new plans (as per Section 6 and the Commitments Register, Appendix 8) are provided in the following sections.

Sustainable management of water resources in the area of the Khor Mor site is a key concern for Pearl Petroleum. Pearl Petroleum and local residents are dependent on groundwater for all water needs. The conclusion of the KM250A Project groundwater impact assessment was that Project groundwater abstraction will not have a significant impact on the groundwater aquifer in this region. However, Pearl Petroleum is concerned that future expansion will put pressure on the local aquifer if it is not managed sustainably.

Therefore, Pearl Petroleum will develop a Water Management Plan with the aim of ensuring that water resources used in the Project during the construction and commissioning phases are used in an environmentally and socially sustainable way, and that any potential negative impacts that may occur as a result of future phases of the KM Expansion are prevented or, if this is not possible, are ALARP.

Towards development of a baseline set of data for the Water Management Plan, Pearl Petroleum is in the processing of setting up a monitoring network for groundwater resources via a series of boreholes. Following collection of approximately one year of data on groundwater level, quality, direction, etc. resource availability will be modelled to allow forward planning. Extraction of groundwater will be planned to allow adequate recharge of the principle groundwater aquifer.

The Water Management Plan will contain information on the following topics:

- processes for the sustainable management of water resources
- general water conservation techniques
- requirements relating to the abstraction of water including the need to undertake impacts assessment to assess the drawdown impact on local people
- requirements relating to the discharge of water including testing prior to discharge and, if necessary, treatment such that the water meets defined standards
- monitoring and reporting requirements.

The requirements of the existing Pearl Petroleum HSSE&SP MS documents ‘Use of Energy, Material and Resources’ and ‘Water Quality Management Procedure’ will be referenced within this plan as required.

11.3.1 Social Investment Program

The SP Standard provides the basis for initiatives and projects that are consistent with the following key themes:

- access to water and energy
- enterprise development
- education
- health.

These will be implemented amongst local stakeholder within the framework of the Social Investment Programme (SIP). Several long-term social investment programmes have been developed as part of the SP Standard (2018-2022), they are aimed at local social and economic development and creation of benefits for stakeholders within Pearl

Petroleum's areas of operation. Social investment spend that is mandated by the KRG is subject to agreement with the MNR. Project-related social investment mitigation measures will be integrated into this plan as appropriate.

As part of a five-year component of the Social Investment Programme (SIP), Pearl Petroleum will seek to establish and support the industry trade skills training provision and formal recognition via certification or references in order to build local sustainable capability. Pearl Petroleum has developed and implemented training programs and initiatives to improve existing skills of local workers, most noticeably by providing monthly English language classes conducted by two full-time English trainers and by delivering elementary development programs for further training and development across a range of disciplines. Technical functional training is coordinated and delivered under the direction of dedicated operations and maintenance support supervisors and forms an integral part of the overall competency programme in place. Furthermore, local national trainees will undergo intensive classroom and on-the-job training to ensure they are competent to move into permanent positions within the gas plant at the time of commissioning the KM250A facility. These efforts will help Pearl Petroleum to achieve their long-term nationalisation objectives.

11.3.2 Local Community Employment Plan

The Local Community Employment Plan (LCEP) prioritises the employment of people from local communities, followed by people from other parts of the KRI. The LCEP will be developed in consultation with local authorities and will be aligned with the overarching recruitment strategy of the Project. Each contractors' recruitment activities will be overseen by Pearl Petroleum's SP Department to ensure adherence to local hiring requirements

11.3.3 Influx Management Strategy

The Influx Management Strategy will outline the Project activities to manage the potential influx of people in search of Project-related economic opportunities or will provide references to other plans where such measures are detailed. It will provide the basis for consideration of measures to minimise potential influx, including (but not limited to) recruitment and procurement procedures, community engagement activities, and engagement with the local authorities. The potential for influx will be embedded in the monitoring activities, such that changes to the baseline conditions in Project-affected communities are identified and any evidence of new settlements of temporary or permanent nature, as well as any community health issues, noise and traffic, sanitary conditions and evidences of extra pressure on existing utilities, infrastructure and other services, are documented and mitigation developed. The differing roles of the Project and local authorities will be outlined and respected, with Pearl Petroleum potentially providing support in spatial and/or infrastructure planning if appropriate.

11.3.4 Livelihood Restoration Plan

Issues associated with land management, acquisition, provision of access during construction and mitigation of physical and economic displacement are managed by Pearl Petroleum in compliance with the national land regulation and the Pearl Petroleum SP Standard. Whilst the MNR is responsible for land acquisition, access and compensation with respect to oil and gas operations in the KRI, Pearl Petroleum has a critical role in supporting and facilitating the process and ensuring that they comply with international standards to which Pearl Petroleum is committed.

Pearl Petroleum is working with the MNR on the development of the comprehensive land acquisition plan to reflect both national regulatory requirements and good international industry practice and to ensure that the acquisition process is conducted in alignment between the various authorities and Pearl Petroleum. The land acquisition and compensation process is subject to formal monitoring and evaluation process by Pearl Petroleum and the MNR. Pearl Petroleum has determined that economic displacement and livelihood loss are likely to occur within the framework of the Project. The assessment and compensation process will be managed by a Project-specific Livelihood Restoration Plan containing a summary of findings and any necessary mitigation actions. The land entry process will require that the EPC Contractor and other construction contractors to undertake pre-construction survey and assets inventory prior the start of construction.

11.3.5 Traffic Management Plan

A Traffic Management Plan will be developed with the aim of minimising any disruption to local traffic related to Project activities and minimising any traffic-related risks to the public. Topics that are likely to be included in the Traffic Management Plan include:

- identifying vehicle routes, route planning and alternative routes
- pre- and post- construction survey requirements
- notification requirements for example:
- notifying the municipalities and police of all approved Project transport routes
- notifying the public of temporary road diversions and closures
- requirements for a journey management system
- driver requirements such as:
    - sources of and number of qualified drivers required
    - training and approval requirements for drivers
    - hours of driving and rest periods
    - security arrangements for drivers, vehicles and loads
    - arrangements for driver communication with control points and vehicle equipment
    - vehicle requirements
- requirements for the diversion and closure of roads
- the emergency recovery of vehicles
- traffic control procedures, including entering and exiting construction areas and the working strip
- identifying emergency service vehicle parking areas.
- identifying construction personnel parking areas
- monitoring and reporting requirements.

The Traffic Management Plan will reference existing documents where relevant, for example, the ‘Driver and Vehicle Policy for Khor Mor LPG’ document.

11.3.6 Biodiversity Plans

Biodiversity management measures will be included in the HSSE&SP MP. These will define the approach to reduce impacts on biodiversity and will address:

- construction planning surveys and pre-clearance surveys
- application of the mitigation hierarchy to ecological receptors: avoid, minimisation, rehabilitation, compensation
- construction phase biodiversity considerations, such as: signage, reducing habitat disturbance, habitat and species protection
- erosion and sediment control measures and soils conservation techniques
- the need for a Biosecurity Plan that describes measure to prevent the introduction of invasive species
- the need for a Bio-restoration Plan that details the measures necessary to restore natural habitats on pipeline route and storage areas after construction activities are complete.

The Bio-restoration Plan will be directed at restoration of natural habitats on KM250A Project flowline routes and storage areas after construction activities are complete. This will include guidance on returning the segregated topsoil to the site and reseeding or replanting areas with native species.

Pearl Petroleum will expect the contractor to develop a Biosecurity Plan that incorporates the following considerations:

- any ecology restoration will utilise native plant species
- all equipment/machinery will be sourced locally to avoid the spread of invasive species.

11.4 Monitoring and reporting

The monitoring and reporting requirements will be specified in the HSSE&SP MP to ensure that monitoring, inspection and audit are undertaken in a systematic way in order to monitor the success of the environmental and social mitigation measures as well as gather data on environmental and social performance, investigation of incidents and nonconforming monitoring results. A monitoring programme will be developed for the project including the monitoring requirements described in the Commitments Register. The HSSE&SP MP will address:

- a monitoring programme describing monitoring locations (based upon the sensitive receptors) and monitoring methodologies (frequency, equipment to be used)
- inspections and audit programme
- non-conformance procedure
- investigation of non-conformances and incidents
- action tracking system
- responsibilities for reporting, content, level of detail and format of reports and reporting deadlines
- internal and external notifications.

11.5 Operations phase

For management of the HSSE&SP MP framework associated with the Project operations phase, the documentation developed for KM250A construction will be updated and implemented throughout the remaining lifetime of the KM250A Project. Where necessary further procedures, plans and strategies will be developed for the operations phase and will form part of the HSSE&SP MP, which in turn will be incorporated into the Corporate HSSE&SP MS. The structure of the operational stage management plans will generally follow the requirements applicable for the construction management plans as specified in this HSSE&SP MP (see Section 11.3), adapted to meet operations phase risks and issues as needed. The operations phase framework will be completed not later than six months before the KM250A Project enters operation.

Additional requirements that will be implemented for the operations phase include but may not be limited to the following:

- development of a Lighting Plan to reduce the long-term impact of light from the plant
- review, and enhancement where required, of existing security arrangements
- development of a draft Transition Training Plan to allow skilled employees to better access employment in other sectors (note: the level of interest in such training amongst workers will be evaluated prior to the finalisation and implementation of the plan).

11.6 Decommissioning

The detailed programme for decommissioning will be determined and agreed with the MNR authorities prior to shut down. Decommissioning and dismantling are expected to be performed by specialist contractors supported by a core team of Project operations and maintenance personnel and will feature:

- use of heavy machinery and plant for demolition
- management of waste streams generated during decommissioning (equipment, piping and leftover chemicals)
- transport of demolition wastes to an approved landfill
- dismantling equipment to manageable sections
- removal of building structures and paved surfaces
- drainage of oil-based liquids and lubricants from equipment, including vessels and piping
- waste management in accordance with the Pearl Petroleum Waste Management Procedure and waste hierarchy principals.

Post-closure monitoring will be carried out before transferring the land to the next land owner.

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APPENDIX 1
HISTORICAL SITE BASELINE FIELD SURVEY RESULTS

Soil

Table A1.1 Soil analytical survey results, mg/kg

Parameter	S1	S2	S3	S4	S5	Project standard
Mercury	BCL	BCL	BCL	BCL	BCL	1
Arsenic	4.65	5.98	4.12	7.42	5.32	20
Zinc	24.2	26.1	23.8	20.7	23.9	200
Cyanide	BCL	BCL	BCL	BCL	BCL	10
Cadmium	1.1	4.1	1.1	2.6	37	3
Chromium*	46	35	23	25	54	$1^{vi}/400^{III}$
Manganese	423	433	354	222	362	500
Magnesium	58.6	65.5	40.4	31.8	72.8	-
Copper	31.8	38.8	42.0	32.1	39.7	100
Lead	4.1	3.8	8.5	9.4	8.3	300
Nickel	43	27	34	32	75	60
Iron	32.4	32.1	29.3	42.6	34.2	-
TPH	3.2	5.2	5.2	6.3	10.2	-

Source: MapCom (2010)

Notes: Red = exceeds Project standard, TPH = total petroleum hydrocarbons (unspecified fraction), BDL = below detection limit (detection limit not reported), * = valency unspecified, III = Chromium III, VI = Chromium VI.

Table A1.2 Chemical properties of soil sampling sites in the study area of Khor Mor block

Extractable metals/ sampling sites	Unit of measurement	Canadian guideline for agricultural	Canadian guideline for residential/industrial commercial	KM-SS1	KM-SS2	KM-SS3	KM-SS4	KM-SS5	KM-SS6	KM-SS7	KM-SS8	KM-SS9	KM-SS10	KM-SS11	KM-SS12
Major cations															
Aluminum	mg/kg DW			22500	19500	16200	20600	22000	27500	19600	16200	15200	17800	14700	22700
Antimony	mg/kg DW	7.5	40	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Arsenic	mg/kg DW	11	18	6.05	2.95	1.56	4.72	5.09	4.29	4.88	3.57	3.83	4.83	3.40	6.75
Barium	mg/kg DW	390	670	62.3	81.6	31	99.5	106	77.8	97.8	89.9	96.2	103	139	57.4
Beryllium	mg/kg DW	4	8	0.745	0.602	0.544	0.717	0.793	0.832	0.748	0.500	0.465	0.535	0.490	0.755
Bismuth	mg/kg DW			<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Boron	mg/kg DW	120	120	5.6	4.4	3	6.1	8.4	11.1	6.4	9.4	8.7	10.4	9.3	6.1
Cadmium	mg/kg DW	1.2	1.9	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Calcium	mg/kg DW			98800	62200	88700	100000	92300	88700	93500	166000	168000	149000	140000	103000
Chromium	mg/kg DW	160	160	53.0	44.2	36.1	38.4	43.3	60.0	37.8	56.8	55.6	63.0	53.7	49.6
Cobalt	mg/kg DW	22	80	12.7	10.8	9.04	11.1	12	15.2	11.3	11.2	10.3	11.6	10.6	12.4
Copper	mg/kg DW	140	230	28.3	17.7	14.7	22.0	22.4	30.6	21.1	20.7	19.1	21.6	22.2	28.4
Iron	mg/kg DW			31700	28500	25200	29700	31400	36500	29400	23300	21600	24300	22200	31300
Lead	mg/kg DW	45 (120)	120	9.4	7.2	6.2	9.5	9.7	10.4	10.1	6.3	5.5	6.0	8.3	9.5
Lithium	mg/kg DW			49.6	33.8	29.7	46.3	50.3	56.5	43.5	28.0	27.2	30.2	27.5	49.3
Magnesium	mg/kg DW			18100	12500	10200	13100	14200	18100	11400	16300	15700	19200	12100	17400
Manganese	mg/kg DW			638	788	682	639	628	638	618	506	455	466	514	531
Mercury	mg/kg DW	0.25 (0.27)	3.9	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Molybdenum	mg/kg DW	6.9	40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.64	0.57	0.53	0.49	<0.40
Nickel	mg/kg DW	100	270	70.4	50.6	39.1	48.3	53.8	80.0	48.6	80.6	75.6	86.9	74.8	66.4
Phosphorus	mg/kg DW			474	450	410	446	492	491	510	550	415	490	791	462
Potassium	mg/kg DW			2710	1810	1330	2200	2620	3360	2220	3250	2430	3110	3440	2680
Selenium	mg/kg DW	2.4	5.5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Silicon	mg/kg DW			196	240	232	228	230	226	217	201	192	200	235	207
Silver	mg/kg DW	20	40	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Sodium	mg/kg DW			134	71	44	116	123	162	106	177	176	199	117	111
Strontium	mg/kg DW			800	110	123	212	420	234	206	353	426	320	183	829
Sulphur	mg/kg DW			112	88	83	97	121	110	126	402	333	369	323	121
Tellurium	mg/kg DW			<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Thallium	mg/kg DW	1	3.3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tin	mg/kg DW			<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Titanium	mg/kg DW			166	476	444	244	343	362	310	406	410	426	303	166
Vanadium	mg/kg DW	86	86	45.1	43	42.9	38.6	40.2	48.0	37.9	44.8	43.2	47.2	39.8	45.0
Zinc	mg/kg DW	340	340	57.4	49.3	41.7	56.3	59.8	68.4	57.0	40.0	34.5	40.0	42.5	56.8
Zirconium	mg/kg DW			<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Petroleum hydrocarbons															
C10 - C12 fraction	mg/kg DW			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
C10 - C40 fraction	mg/kg DW			<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C12 - C16 fraction	mg/kg DW			<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
C16 - C35 fraction	mg/kg DW			<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C35 - C40 fraction	mg/kg DW			<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Physical parameters															
Dry matter @ 105°C	%			90.2	89	86.9	90.2	90.2	89.9	89.6	84.7	86.3	85.7	83.8	91.1
pH (H2O)				8.5	8.4	8.2	8.2	8.3	8.3	8.2	8.3	8.2	8.2	8.2	8.1
BTEX															

Benzene	mg/kg DW			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Toluene	mg/kg DW			<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Ethylbenzene	mg/kg DW			<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
meta- & para-Xylene	mg/kg DW			<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
ortho-Xylene	mg/kg DW			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Sum of BTEX	mg/kg DW			<0.090	<0.090	<0.090	<0.090	<0.090	<0.090	<0.090	<0.090	<0.090	<0.090	<0.090	<0.090
Sum of xylenes	mg/kg DW			<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030

Source: MapCom (2018)

Water

Table A1.3 Physical, chemical and biological properties of groundwater and surface water system in the study area (MapCom, 2010)

S.N	Parameter (units)	W1	W2	W3	W4	W5	WB Norms
1.	Temp. (ºC)	22.4	19.8	20.6	19.5	21.7	-
2.	pH	7.7	8.1	8.2	7.3	7.8	6.5 – 8.5
3.	EC (µs.cm^{-1})	685	742	514	683	455	400 – 600
4.	T.S.S. (ppm)	82	110	65	92	45	250
5.	D.O. (mg.l^{-1})	4.8	5.2	6.8	4.7	7.2	7.0
6.	B.O.D$_5$ (mg.l^{-1})	12	8.0	12	16	3.1	0.0 – 1.0
7.	C.O.D (mg.l^{-1})	84	74	56	58	32	10 – 20
8.	$SO_4^{=}$ (mg.l^{-1})	215	310	345	410	280	200 – 400
9.	NO_3 (mg.l^{-1})	64	45	52	37	54	45
10.	MPN (Cells. 100 ml^{-1})	2.2	9.2	2.2	9.2	9.2	0.0

Source: MapCom (2010)

Note: WB = World Bank, Temp. = Temperature, ºC = degrees Celsius, pH – potential of hydronium, EC = Electrical Conductivity, µs.cm^{-1} = micro siemens per centimetre, mg.l^{-1} = milligram per liter, TSS = Total Suspende Solids, D.O. = Dissolved oxygen, B.O.D$_5$ = Biological Oxygen Demand of five day incubation time, C.O.D = Chemical Oxygen Demand, $SO_4^{=}$ = Sulfate, NO_3 = Nitrate, MPN = Most Probable Number of Fecal coliform bacteria.

Table A1.4 Physical, chemical and biological properties of groundwater and surface water system in the study area (MapCom, 2018)

Sampling sites		GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	WHO Norms
Parameters	**Unit**									
Aggregate parameters										
Calcium Hardness	mmol/L	2.9	2.7	4.82	1.42	1.93	2.41	1.14	2.43	
Hardness	mmol/L	3.4	2.56	6.91	1.63	3.22	2.79	1.47	2.81	
Hardness as CaCO3	mg $CaCO_3$/L	324	256	691	163	322	279	147	281	500
Magnesium Hardness	mg $CaCO_3$/L	33.8	28.9	210	21.7	129	38.6	33.2	38.2	
Dissolved metals/major cations										
Aluminium	mg/L	0.016	0.014	0.020	0.011	0.013	0.015	0.010	0.015	
Antimony	mg/L	<0.010	<0.010	<0.010	<0.0 10	<0.0 10	<0.0 10	<0.010	<0.010	
Arsenic	mg/L	<0.0050	<0.0050	<0.0050	<0.0 050	<0.0 050	<0.0 050	<0.0050	<0.0050	0.001
Barium	mg/L	0.220	0.106	0.0684	0.0287	0.108	0.196	0.171	0.200	
Beryllium	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	
Boron	mg/L	0.025	0.017	0.255	0.019	0.093	0.034	0.034	0.034	
Cadmium	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	0.003
Calcium	mg/L	101	81.2	166	50.1	69.6	87.2	40.5	89.0	150
Chromium	mg/L	<0.0010	<0.0010	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	0.0011	0.05
Cobalt	mg/L	<0.002 0	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	
Copper	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0044	<0.0010	<0.0010	<0.0010	2
Iron	mg/L	<0.0020	<0.0020	0.0050	<0.0020	0.0996	<0.0020	<0.00050	<0.0020	0.3
Lead	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.01
Lithium	mg/L	0.0069	0.0069	0.0297	0.0037	0.0306	0.0059	0.0054	0.0072	
Magnesium	mg/L	7.11	6.39	44.5	4.64	28	8.40	7.30	8.34	100
Manganese	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.4
Molybdenum	mg/L	<0.002	<0.002	<0.002	<0.0	<0.0	<0.0	<0.00	<0.00	
Nickel	mg/L	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.07
Phosphorus	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	
Potassium	mg/L	1.76	0.132	15.9	0.104	1.91	0.525	0.338	0.465	250
Selenium	mg/L	<0.010	<0.010	<0.000	<0.010	<0.010	<0.010	<0.010	<0.010	0.01
Silver	mg/L	<0.0010	<0.0010	<0.0010	<0.010	<0.010	<0.010	<0.0010	<0.0010	
Sodium	mg/L	8.28	7.59	64.4	6.74	90.1	12.3	12.3	12.2	200
Thallium	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	
Vanadium	mg/L	0.0015	<0.0010	<0.0010	<0.0010	0.0071	0.0021	0.0035	0.0019	
Zinc	mg/L	<0.0020	<0.0020	<0.0020	<0.010	0.0384	0.0218	0.0042	0.0231	3
Petroleum hydrocarbons										
C10 - C12 Fraction	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	
C10 - C40 Fraction	µg/L	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	
C12 - C16 Fraction	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	
C16 - C35 Fraction	µg/L	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	
C35 - C40 Fraction	µg/L	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	
Physical parameters										
Turbidity	NTU	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Total metals/major cations										
Magnesium	mg/L	8.21	7.04	51	5.28	31.4	9.39	8.06	9.28	
Mercury	µg/L	0.047	<10.0	0.046	<10.0	<10.0	<10.0	<10.0	<10.0	
Potassium	mg/L	2.10	0.146	18.2	0.126	2.21	0.608	0.424	0.587	
Sodium	mg/L	9.63	8.49	75.2	7.66	100	13.6	13.7	13.6	
Other parameters										

pH	-	7.42	7.62	7.88	7.72	7.48	7.93	7.58	7.93	6.5-8.5
EC	µS.cm-^{1}	520	761	923	290	631	772	547	772	1000
Salinity	ppt	0.26	0.23	0.45	0.14	0.32	0.37	0.24	0.37	
TDS	ppt	338	494.6	599.9	188	410	501	355	501	500
Well Depth	m	Spring	Spring	55	-	2.5	6	Storage Tank	6	
Water Table Depth	m	Spring	Spring	6	-	20cm	2.5	Storage Tank	2.5	
Temperature	C^{o}	19.4	19.7	21.11	21.7	19.9	20.3	19.8	20.3	
DO	ppm	2.99	2.84	2.69	7.99	4.23	3.45	2.87	3.45	
BOD5	ppm	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
COD	ppm	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	
Bacteriological analysis										
MPN	MPN/ml	160	5	28	14	1	240	1	92	<5
T.P.C	-	10^3	10^3	10^3	10^3	10^3	10^3	10^3	10^3	100
Non-metallic inorganic parameters										
Base neutralizing (Acidity) capacity pH 8.3	mmol/L	0.417	0.235	0.203	<0.150	<0.150	1.61	<0.150	<0.150	3
Base neutralizing (Acidity) capacity pH 4.5	mmol/L	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150	
Acid neutralizing capacity (alkalinity) pH 4.5	mmol/L	5.17	3.66	5.67	3.11	1.06	4.27	2.48	4.21	3.00
Acid neutralizing capacity (alkalinity) pH 8.3	mmol/L	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150	
Biochemical Oxygen Demand (BOD 5)	mg/L	<1.0	<1.0	<1.0	<1.0	1.6	<1.0	<1.0	<1.0	5
Chemical Oxygen Demand (COD-Cr)	mg/L	<5.0	<5.0	<5.0	<5.0	13	<5.0	<5.0	<5.0	
Sulphate as SO4 2-	mg/L	10.5	10.3	130	6.34	117	11.3	6.64	11.8	250
Nitrate	mg/L	17.8	19.7	98.7	29.9	282	20.6	19.6	20.8	50
Nitrates as N	mg/L	4.02	4.46	22.3	6.76	63.8	4.66	4.43	4.70	
Sulphate as SO4 2-	mg/L	46.9	70.8	388	17.5	242	73.9	34.0	77.2	250

Biodiversity

Table A1.5 Rare plant species identified by Nature Iraq (2017)

Scientific name	IUCN (2019) status	Habitat of occurrence	Countries of occurrence according to IUCN (2019)
Typha lugdunensis	Data Deficient	Wetlands (inland), artificial / aquatic & marine	Austria, France, Germany & Switzerland. However, it was probably introduced to Europe.
Equisetum arvense	Least Concern	Forest, wetlands (inland), grassland, artificial / aquatic & marine	>30 countries
Rubus caesius	Least Concern	Forest, grassland, shrubland, marine coastal / supratidal	>30 countries
Quercus macranthera	Not assessed		Iran, Lebanon-Syria, North Caucasus, Transcaucasus; Turkey
Linum velutinum	Not Assessed		Iraq (NE-Iraq)
Carlina kurdica	Not Assessed		Iraq (NE-Iraq), Syria (Jazira)
Pisum sativum	Least Concern	Artificial/Terrestrial, Shrubland	>30 countries
Paronychia kurdica	Not Assessed		Turkey, Iran, Iraq, Lebanon, Syria Armenia, Azerbaijan, Georgia
Dianthus basianicus	Not Assessed		Iran (W-Iran), Iraq (NW-Iraq)
Ornithogalum iraqense	Not Assessed		Northern Iraq

Table A1.6 Results of fauna species screening

Common name	Scientific name	IUCN (2019) status	Species range	Habitat type	Likelihood of species to use habitats in the study area	Likelihood of species occurring in project footprint *– assuming the site is fenced*
Bunni's Short-tailed Bandicoot Rat	*Nesokia bunni*	EN	Iraq, presence in Iran is uncertain	It is poorly known, but it appears to be a terrestrial species which prefer moist habitats, such as marshes and swamps. Endemic to the marshlands of south-eastern Iraq in the Tigris and Euphrates Valleys.	Unlikely due to restricted range	Unlikely due to restricted range however further analysis is required to validate this assumption.
Goitered gazelle	*Gazella subgutturosa*	Global VU; Mediterranean CR	Afghanistan, Azerbaijan, Bahrain, China, Iran, Iraq, Jordan, Kazakhstan, Kyrgyzstan, Mongolia; Oman, Pakistan, Saudi Arabia, Syrian Arab Republic, Tajikistan, Turkey, Turkmenistan, United Arab Emirates, Uzbekistan & Yemen	Inhabits a wide range of semi-desert and desert habitats	Unlikely, thought to be restricted to Chamchamal KBA & IBA but	Unlikely
Arabian Sand Gazelle	*Gazella marica*	VU	Iraq, Jordan, Kuwait; Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates & Yemen	Deserts, including sand dunes and areas of sand and gravel as well as coastal flats; it avoids steep and rocky areas.	Possible	Unlikely
leopard	*Panthera pardus*	VU; Mediterranean CR	>30 counties including Iraq	wide range of habitats including desert and semi-desert, mountainous habitats & rainforests.	Unlikely	Unlikely
marbled polecat	*Vormela peregusna*	Global VU; Europe VU; Mediterranea	Afghanistan; Armenia; Azerbaijan; Bulgaria; China; Egypt (Sinai); Georgia; Greece; Iran, Islamic Republic of; Iraq; Israel; Kazakhstan; Lebanon; Mongolia; Montenegro; North Macedonia; Pakistan; Romania; Russian Federation; Serbia; Syrian Arab Republic; Turkey;	Desert, semi-desert and steppe habitats	Possible	Possible assuming individuals can climb over the fence

Common name	**Scientific name**	**IUCN (2019) status**	**Species range**	**Habitat type**	**Likelihood of species to use habitats in the study area**	**Likelihood of species occurring in project footprint *– assuming the site is fenced***
		n VU	Turkmenistan; Ukraine; Uzbekistan			
grey wolf	*Canis lupus*	LC	>30 counties including Iraq	Forest, desert, rocky areas (e.g. inland cliffs, mountain peaks), shrubland, grassland & wetlands (inland)	Possible	unlikely
brown bear	*Ursus arctos*	LC	Afghanistan; Albania; Armenia; Azerbaijan; Belarus; Bosnia and Herzegovina; Bulgaria; Canada; China; Croatia; Estonia; Finland; France; Georgia; India; Iran, Islamic Republic of; Iraq; Italy; Japan; Kazakhstan; Korea, Democratic People's Republic of; Latvia; Mongolia; Montenegro; Nepal; North Macedonia; Norway; Pakistan; Poland; Romania; Russian Federation; Serbia; Slovakia; Slovenia; Spain; Sweden; Tajikistan; Ukraine; United States; Uzbekistan	Desert, forest, wetlands (inland), grassland, & shrubland.	Unlikely	Unlikely
striped hyaena	*Hyaena Hyaena*	Global NT; Mediterranean VU	Afghanistan; Algeria; Armenia; Azerbaijan; Burkina Faso; Cameroon; Chad; Djibouti; Egypt; Ethiopia; Georgia; India; Iran, Islamic Republic of; Iraq; Israel; Jordan; Kenya; Lebanon; Libya; Mali; Mauritania; Morocco; Nepal; Niger; Nigeria; Oman; Pakistan; Saudi Arabia; Senegal; Syrian Arab Republic; Tajikistan; Tanzania, United Republic of; Tunisia; Turkey; Turkmenistan; Uganda; Uzbekistan; Western Sahara; Yemen	Wetlands (inland), savanna, shrubland, forest, grassland.	Possible	Unlikely
wild boar	*Sus scrofa*	LC	>30 counties including Iraq	Wide variety of temperate and tropical habitats including semi-desert to tropical	Possible	Unlikely

Common name	Scientific name	IUCN (2019) status	Species range	Habitat type	Likelihood of species to use habitats in the study area	Likelihood of species occurring in project footprint *– assuming the site is fenced*
				rain forests, temperate woodlands, grasslands, shrubland, often raiding agricultural land for food.		

Note: LC = IUCN listed Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered; CR = Critically Endangered

Table A1.7 Rare and threatened bird species with ranges that overlap the study area

Common name	Scientific name	IUCN (2019) status	Habitat of occurrence (IUCN, 2019)	Migratory status	Congregatory status
sociable lapwing	*Vanellus gregarius*	CR	Desert, wetlands (inland), grassland, artificial/terrestrial	Full migrant	Congregatory (and dispersive)
saker falcon	*Falco cherrug*	EN	Marine intertidal, wetlands (inland), grassland, shrubland, artificial/terrestrial	Full migrant	Congregatory (and dispersive)
Northern bald ibis	*Geronticus eremita*	EN	Marine coastal/supratidal, caves and subterranean habitats (non-aquatic), rocky areas (eg. inland cliffs, mountain peaks), wetlands (inland), grassland, shrubland, artificial/terrestrial – possibly extinct in Iraq (IUCN, 2019)	Full Migrant	Congregatory (and dispersive)
Egyptian vulture	*Neophron percnopterus*	EN	Rocky areas (e.g. inland cliffs, mountain peaks), wetlands (inland), grassland, shrubland, savanna, artificial/terrestrial	Full migrant	Congregatory (and dispersive)
white-headed duck	*Oxyura leucocephala*	EN	Wetlands (inland), artificial/aquatic & marine, marine coastal/supratidal	Full migrant	Congregatory (and dispersive)
steppe eagle	*Aquila nipalensis*	EN	Rocky areas (e.g. inland cliffs, mountain peaks), grassland, savanna	Full migrant	Congregatory (and dispersive)
great bustard	*Otis tarda*	VU	Grassland, artificial/terrestrial	Full migrant	Not congregatory
Marbled Teal	*Marmaronetta angustirostris*	VU	Wetlands (inland), marine coastal/supratidal, artificial/aquatic & marine	Full migrant	Congregatory (and dispersive)
Lesser White-fronted Goose	*Anser erythropus*	VU	Artificial/terrestrial, grassland, rocky areas (eg. inland cliffs, mountain peaks), shrubland, wetlands (inland)	Full migrant	Congregatory (and dispersive)
greater spotted eagle	*Clanga clanga*	VU	Forest, wetlands (inland), shrubland, artificial/aquatic & marine, grassland	Full migrant	Congregatory (and dispersive)
Asian houbara	*Chlamydotis macqueenii*	VU	Desert, grassland, artificial/terrestrial	Full migrant	Not congregatory
European turtle-dove	*Streptopelia turtur*	VU	Forest, artificial/terrestrial, shrubland	Full migrant	Not congregatory

Table A1.8 Avifauna species identified from previous surveys (Nature Iraq)

Scientific name	English name	IUCN (2019) status	Status
Ammoperdix griseogularis	See-see Partridge	LC	Resident
Milvus migrans	Black Kite	LC	Passage migrant
Neophron percnopterus	Egyptian Vulture	EN	Passage migrant
Circus cyaneus	Hen Harrier	LC	Passage migrant and winter visitor
Circus macrourus	Pallid Harrier	NT	Passage migrant and winter visitor
Falco cherrug	Saker Falcon	EN	Passage migrant
Accipiter nisus	Eurasian Sparrowhawk	LC	Passage migrant and winter visitor
Buteo buteo vulpinus	Steppe Buzzard	LC	Passage migrant and winter visitor
Buteo rufinus	Long-legged Buzzard	LC	Passage migrant
Aquila clanga	Greater Spotted Eagle	VU	Passage migrant
Aquila nipalensis	Steppe Eagle	CR	Passage migrant
Aquila heliaca	Eastern Imperial Eagle	VU	Passage migrant and winter visitor
Falco tinnunculus	Common Kestrel	LC	Passage migrant and winter visitor
Vanellus indicus	Red-wattled Lapwing	LC	Resident
Vanellus leucurus	White-tailed Lapwing	LC	Passage migrant
Columba livia	Rock Dove	LC	Resident
Streptopelia decaocto	Eurasian Collared Dove	LC	Resident
Stigmatopelia senegalensis	Laughing Dove	LC	Resident
Athene noctua	Little Owl	LC	Resident
Apus apus	Common Swift	LC	Passage migrant
Coracias garrulus	European Roller	LC	Passage migrant
Merops apiaster	European Bee-eater	LC	Passage migrant
Upupa epops	Eurasian Hoopoe	LC	Summer breeder and passage migrant
Lanius collurio	Red-backed shrike	LC	Passage migrant
Lanius minor	Lesser Grey Shrike	LC	Passage migrant
Lanius senator	Woodchat Shrike	LC	Passage migrant
Lanius nubicus	Masked Shrike	LC	Passage migrant

Pica pica	Eurasian Magpie	LC	Passage migrant
Corvus monedula	Western Jackdaw	LC	Passage migrant and winter visitor
Corvus frugilegus	Rook	LC	Passage migrant and winter visitor
Corvus corax	Northern Raven	LC	Resident
Melanocorypha calandra	Calandra Lark	LC	Resident and passage migrat
Ammomanes deserti	Desert Lark	LC	Resident and passage migrant
Galerida cristata	Crested Lark	LC	Resident
Alauda arvensis	Eurasian Skylark	LC	Passage migrant and winter visitor
Riparia riparia	Sand Martin	LC	Passage migrant
Hirundo rustica	Barn Swallow	LC	Passage migrant
Cecropis daurica	Red-rumped Swallow	LC	Passage migrant
Phylloscopus trochilus	Willow Warbler	LC	Passage migrant
Sitta neumayer	Western Rock Nuthatch	LC	Resident
Phylloscopus collybita	Common Chiffchaff	LC	Passage migrant
Sturnus vulgaris	Common Starling	LC	Passage migrant and winter visitor
Phoenicurus ochruros	Western Black Redstart	LC	Passage migrant
Phoenicurus phoenicurus	Common Redstart	LC	Passage migrant
Oenanthe isabellina	Isabelline Wheatear	LC	Passage migrant
Oenanthe oenanthe	Northern Wheatear	LC	Passage migrant
Oenanthe finschii	Finsch's Wheatear	LC	Passage migrant and possible breeder
Oenanthe melanoleuca	Eastern Black-eared Wheatear	LC	Possible Breeder
Oenanthe albonigra	Hume's Wheatear	LC	Resident breeder
Passer domesticus	House Sparrow	LC	Resident
Carpospiza brachydactyla	Pale Rockfinch	LC	Passage migrant and possible breeder
Motacilla flava	Yellow Wagtail	LC	Passage migrant
Motacilla cinerea	Grey Wagtail	LC	Passage migrant
Motacilla alba	White Wagtail	LC	Passage migrant
Anthus spinoletta	Water Pipit	LC	Passage migrant
Fringilla coelebs	Common Chaffinch	LC	Passage migrant

Carduelis carduelis	European Goldfinch	LC	Passage migrant
Emberiza melanocephala	Black-headed Bunting	LC	Passage migrant and possible breeder
Miliaria calandra	Corn Bunting	LC	Passage migrant

APPENDIX 2
KM250A PROJECT ESIA BASELINE SURVEY RESULTS (SOIL, WATER, AIR, LAND USE, TRAFFIC, ARCHAEOLOGY), LABORATORY CERTIFICATES AND PHOTOGRAPHS

SOIL

Table A2.1 Soil sampling location photographs

SS01	
	
SS02	
	
SS03	
	
SS04	
	
SS05	


SS06


SS07


SS08

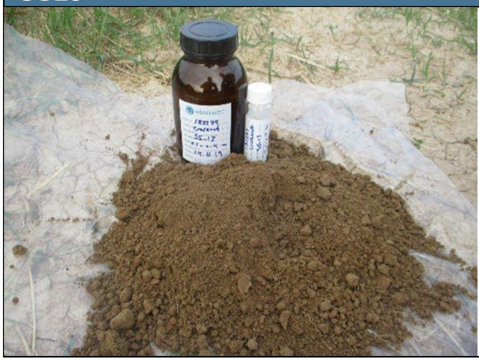

SS09


SS10

SS11

SS12

SS13



Soil sampling laboratory results:

Al Futtaim Element Materials Technology Dubai L.L.C
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Dubai, United Arab Emirates

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Analytical Report

Job Ref. No. : 79963
Report No : 111036
Date Reported : 25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/ Soil
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

مـركـز الإمـارات الـعـالـمـي للاعـتـمـاد
Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID		79963-1	79963-2	79963-3	
Date Received		16/12/2019	16/12/2019	16/12/2019	
Sampled By		Karrar Kamal	Karrar Kamal	Karrar Kamal	
Sampling Date		14/11/2019	14/11/2019	14/11/2019	
Sampling Time		Not Given	Not Given	Not Given	
Sample Sub Matrix		Soil	Soil	Soil	
Sampling Location		Not Given	Not Given	Not Given	
Client Sample ID		SS01 / X-484346 - Y-3887945 / 0.1-0.4m	SS02 / X-483340 - Y-3887510 / 0.1-0.4m	SS03 / X-484181 - Y-3887266 / 0.1-0.4m	
Analyte	**Units**	**Results**	**Results**	**Results**	**Method Limit of Detection**
Metals					
Cadmium (Cd)	mg/kg	<0.5	0.6	0.7	0.5
Arsenic (As)	mg/kg	4.1	3.6	3.0	1.0
Barium (Ba)	mg/kg	101	123	137	3.0
Copper (Cu)	mg/kg	19.0	21.1	20.0	3.0
Lead (Pb)	mg/kg	8.1	9.4	7.0	1.0
Nickel (Ni)	mg/kg	75.6	79.7	80.1	1.0
Selenium (Se)	mg/kg	<3.0	<3.0	<3.0	3.0
Zinc (Zn)	mg/kg	47.6	53.3	51.5	3.0
Chromium (VI)	mg/kg	<0.4	<0.4	<0.4	0.4
Mercury (Hg)	mg/kg	0.017	0.017	0.013	0.010
Hydrocarbons					
VPH C5-C10	mg/kg	<0.05	<0.05	<0.05	0.05
EPH C10-C40	mg/kg	53	<50	89	50

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Analytical Report

Job Ref. No. : 79963
Report No : 111036
Date Reported : 25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/ Soil
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

مركز الإمارات العالمي للاعتماد
Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID		79963-4	79963-5	79963-6	
Date Received		16/12/2019	16/12/2019	16/12/2019	
Sampled By		Karrar Kamal	Karrar Kamal	Karrar Kamal	
Sampling Date		14/11/2019	14/11/2019	14/11/2019	
Sampling Time		Not Given	Not Given	Not Given	
Sample Sub Matrix		Soil	Soil	Soil	
Sampling Location		Not Given	Not Given	Not Given	
Client Sample ID		SS04 / X-483599 - Y-3886433 / 0.1-0.4m	SS05 / X-484681 - Y-3886904 / 0.1-0.4m	SS06 / X-483669 - Y-3887283 / 0.1-0.4m	
Analyte	**Units**	**Results**	**Results**	**Results**	**Method Limit of Detection**
Metals					
Cadmium (Cd)	mg/kg	<0.5	<0.5	<0.5	0.5
Arsenic (As)	mg/kg	2.7	3.4	4.9	1.0
Barium (Ba)	mg/kg	112	270	134	3.0
Copper (Cu)	mg/kg	17.9	21.7	20.5	3.0
Lead (Pb)	mg/kg	6.7	7.1	6.9	1.0
Nickel (Ni)	mg/kg	67.8	81.6	80.7	1.0
Selenium (Se)	mg/kg	<3.0	<3.0	<3.0	3.0
Zinc (Zn)	mg/kg	47.5	56.8	52.3	3.0
Chromium (VI)	mg/kg	<0.4	<0.4	<0.4	0.4
Mercury (Hg)	mg/kg	0.012	0.035	0.014	0.010
Hydrocarbons					
VPH C5-C10	mg/kg	<0.05	<0.05	<0.05	0.05
EPH C10-C40	mg/kg	<50	72	<50	50

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Analytical Report

Job Ref. No.	:	79963
Report No	:	111036
Date Reported	:	25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/ Soil
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

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002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID		79963-7	79963-8	79963-9	
Date Received		16/12/2019	16/12/2019	16/12/2019	
Sampled By		Karrar Kamal	Karrar Kamal	Karrar Kamal	
Sampling Date		14/11/2019	14/11/2019	14/11/2019	
Sampling Time		Not Given	Not Given	Not Given	
Sample Sub Matrix		Soil	Soil	Soil	
Sampling Location		Not Given	Not Given	Not Given	
Client Sample ID		SS07 / X-483823 - Y-3887283 / 0.1-0.4m	SS08 / X-483923 - Y-3886816 / 0.1-0.4m	SS09 / X-484210- Y-3886672 / 0.1-0.4m	
Analyte	**Units**	**Results**	**Results**	**Results**	**Method Limit of Detection**
Metals					
Cadmium (Cd)	mg/kg	<0.5	0.7	0.6	0.5
Arsenic (As)	mg/kg	3.9	3.7	4.1	1.0
Barium (Ba)	mg/kg	182	99.5	95.4	3.0
Copper (Cu)	mg/kg	19.4	17.6	17.1	3.0
Lead (Pb)	mg/kg	6.2	6.2	6.5	1.0
Nickel (Ni)	mg/kg	76.0	72.4	69.9	1.0
Selenium (Se)	mg/kg	<3.0	<3.0	<3.0	3.0
Zinc (Zn)	mg/kg	55.6	48.3	46.9	3.0
Chromium (VI)	mg/kg	<0.4	<0.4	<0.4	0.4
Mercury (Hg)	mg/kg	0.014	0.012	0.012	0.010
Hydrocarbons					
VPH C5-C10	mg/kg	<0.05	<0.05	<0.05	0.05
EPH C10-C40	mg/kg	65	<50	<50	50

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Analytical Report

Job Ref. No. : 79963
Report No : 111036
Date Reported : 25/12/2019

Client: RSK ENVIRONMENT LLC – IRAQ BRANCH
Al Majal Business Park
Basrah, Iraq
BASRAH, IRAQ
Attn: Jessica Hommelhoff
Project ID: 182279/ Soil
Project Name: Crescent
Project Location: Kormor
Tel. No: +964 782 784 6339

Approved by:

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002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79963-10	79963-11	79963-12	
Date Received	16/12/2019	16/12/2019	16/12/2019	
Sampled By	Karrar Kamal	Karrar Kamal	Karrar Kamal	
Sampling Date	14/11/2019	14/11/2019	14/11/2019	
Sampling Time	Not Given	Not Given	Not Given	
Sample Sub Matrix	Soil	Soil	Soil	
Sampling Location	Not Given	Not Given	Not Given	
Client Sample ID	SS10 / X-484246 - Y-3886585 / 0.1-0.4m	SS11 / X-484281 - Y-3887167 / 0.1-0.4m	SS12 / X-484060 - Y-3887549 / 0.1-0.4m	

Analyte	**Units**	**Results**	**Results**	**Results**	**Method Limit of Detection**
Metals					
Cadmium (Cd)	mg/kg	<0.5	<0.5	0.6	0.5
Arsenic (As)	mg/kg	2.8	3.4	4.3	1.0
Barium (Ba)	mg/kg	91.0	98.6	93.8	3.0
Copper (Cu)	mg/kg	16.8	22.1	19.7	3.0
Lead (Pb)	mg/kg	6.4	7.6	7.9	1.0
Nickel (Ni)	mg/kg	67.9	84.7	74.8	1.0
Selenium (Se)	mg/kg	<3.0	<3.0	<3.0	3.0
Zinc (Zn)	mg/kg	46.9	57.4	53.8	3.0
Chromium (VI)	mg/kg	<0.4	<0.4	<0.4	0.4
Mercury (Hg)	mg/kg	0.013	0.020	0.015	0.010
Hydrocarbons					
VPH C5-C10	mg/kg	<0.05	<0.05	<0.05	0.05
EPH C10-C40	mg/kg	<50	<50	<50	50

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Analytical Report

Job Ref. No.	:	79963
Report No	:	111036
Date Reported :		25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/ Soil
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

مـركـز الإمـارات الـعـالـمـي للاعـتـمـاد
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Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79963-13
Date Received	16/12/2019
Sampled By	Karrar Kamal
Sampling Date	14/11/2019
Sampling Time	Not Given
Sample Sub Matrix	Soil
Sampling Location	Not Given
Client Sample ID	SS13 / X-484346 - Y-3887945 / 0.1-0.4m

Analyte	Units	Results	Results	Results	Method Limit of Detection
Metals					
Cadmium (Cd)	mg/kg	<0.5			0.5
Arsenic (As)	mg/kg	3.4			1.0
Barium (Ba)	mg/kg	117			3.0
Copper (Cu)	mg/kg	19.7			3.0
Lead (Pb)	mg/kg	6.9			1.0
Nickel (Ni)	mg/kg	76.1			1.0
Selenium (Se)	mg/kg	<3.0			3.0
Zinc (Zn)	mg/kg	51.6			3.0
Chromium (VI)	mg/kg	<0.4			0.4
Mercury (Hg)	mg/kg	0.013			0.010
Hydrocarbons					
VPH C5-C10	mg/kg	<0.05			0.05
EPH C10-C40	mg/kg	<50			50

Method of Analysis

Method Name	Reference
Chromium (Hexavalent) [HACH 8023] Solids-DXB	HACH [8023]
EPH C10-C40 by GC-FID [EPA 8015B] SSS-DXB$	EPA [8015B]
Mercury by PSA [EPA 245.7] SSS-DXB$	EPA [245.7]
Metals ICP OES [APHA 3120 B] SSS-DXB$	APHA [3120 B]
VPH C5-C10 by GC-FID [EPA 8015B]-SSS-DXB$	EPA [8015B]

* Reference Method Modified

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Analytical Report

Job Ref. No. :	79963
Report No :	111036
Date Reported :	25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/ Soil
Project Name:	Crescent
Project Location:	Kormor
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Approved by:

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Emirates International Accreditation Centre
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Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Comments:

· Tested By : AAP, JCH, SKR
· Date Tested: 23/12/2019 to 24/12/2019

. Please note that if the sample has to be diluted due to the matrix, the reported Limit of Detection (LOD) value will increase from the method LOD.

. Any APHA methods stated herein are documented in-house procedures, referenced to 23rd edition.

. Test methods marked with $ are EIAC (formerly DAC) accredited.

WATER

Table A2.2 Water sampling location photographs

Paryawla – well	
	
WW-2	
	
WW-3	
	
Khor Mor Gawra – spring	
	
Taza Shar – spring	


Shekh Hameed – spring


SP-2


SP-4


GW-5


Zhazh – spring	
	
Takhta Mina Saru – spring	
	
Ibrahim Ghulam – spring	
	

Water sampling chemical laboratory results:

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Analytical Report

Job Ref. No.	:	79957
Report No	:	111038
Date Reported	:	25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

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Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-1	79957-2	79957-3
Date Received	16/12/2019	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given	Not Given
Sampling Date	11/11/2019	11/11/2019	11/11/2019
Sampling Time	Not Given	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water	Ground Water
Sampling Location	Not Given	Not Given	Not Given
Client Sample ID	Kormor Gawra-Spring / X-480842-Y-3886081	Taza Shaher -Spring / X-485378- Y-3882854	Sheikha Hammeed-Spring / X-486333-Y-3881433

Analyte	Units	Results	Results	Results	Method Limit of Detection
Inorganic Parameters					
pH Value @ 20°C	pH units	8.2	7.8	7.7	-
Total Dissolved Solids	mg/L	239	328	375	5
Turbidity	NTU	<0.1	1.8	2.8	0.1
Total Hardness	mg/L	191	370	370	1
Surfactants Anionic	mg/L	0.015	0.018	0.017	0.002
Anions					
Fluoride	mg/L	0.5	0.4	0.3	0.1
Nitrate	mg/L	0.66	0.49	1.02	0.04
Nitrite	mg/L	0.016	0.020	0.026	0.016
Sulphate	mg/L	23.0	33.0	42.0	5
Chloride	mg/L	7.0	9.5	11.0	2
Metals					
Aluminium (Al)	mg/L	<0.01	<0.01	<0.01	0.01
Chromium (VI)	mg/L	<0.05	<0.05	<0.05	0.05
Arsenic (As)	mg/L	<0.01	<0.01	<0.01	0.01
Barium (Ba)	mg/L	0.14	0.23	0.28	0.01
Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	0.001
Calcium (Ca)	mg/L	66.0	135	136	0.1
Copper (Cu)	mg/L	<0.01	<0.01	<0.01	0.01
Iron (Fe)	mg/L	<0.01	<0.01	<0.01	0.01
Lead (Pb)	mg/L	<0.01	<0.01	<0.01	0.01

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Analytical Report

Job Ref. No. : 79957
Report No : 111038
Date Reported : 25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

مـركـز الإمـارات الـعـالـمـي لـلاعـتـمـاد
Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-1	79957-2	79957-3
Date Received	16/12/2019	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given	Not Given
Sampling Date	11/11/2019	11/11/2019	11/11/2019
Sampling Time	Not Given	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water	Ground Water
Sampling Location	Not Given	Not Given	Not Given
Client Sample ID	Kormor Gawra-Spring / X-480842-Y-3886081	Taza Shaher -Spring / X-485378- Y-3882854	Sheikha Hammeed-Spring / X-486333-Y-3881433

Analyte	**Units**	**Results**	**Results**	**Results**	**Method Limit of Detection**
Metals - Continued					
Magnesium (Mg)	mg/L	6.4	7.9	7.2	0.1
Manganese (Mn)	mg/L	<0.01	<0.01	<0.01	0.01
Nickel (Ni)	mg/L	<0.01	<0.01	<0.01	0.01
Selenium (Se)	mg/L	<0.01	<0.01	<0.01	0.01
Sodium (Na)	mg/L	11.6	12.2	8.0	0.1
Zinc (Zn)	mg/L	<0.01	<0.01	<0.01	0.01
Mercury (Hg)	µg/L	<0.030	<0.030	<0.030	0.030
Hydrocarbons					
EPH C10-C40	µg/L	<50	129	<50	50
VPH C5-C10	µg/L	<7	<7	<7	7
PAH's					
Acenaphthene	µg/L	<0.01	<0.01	<0.01	0.01
Acenaphthylene	µg/L	<0.01	<0.01	<0.01	0.01
Anthracene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(a)anthracene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(a)pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(b)fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(g,h,i)perylene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(k)fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Chrysene	µg/L	<0.01	<0.01	<0.01	0.01
Dibenzo(a,h)anthracene	µg/L	<0.01	<0.01	<0.01	0.01

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Analytical Report

Job Ref. No.	:	79957
Report No	:	111038
Date Reported :		25/12/2019

Client: RSK ENVIRONMENT LLC – IRAQ BRANCH
Al Majal Business Park
Basrah, Iraq
BASRAH, IRAQ
Attn: Jessica Hommelhoff
Project ID: 182279/Water
Project Name: Crescent
Project Location: Kormor
Tel. No: +964 782 784 6339

Approved by:

002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-1	79957-2	79957-3
Date Received	16/12/2019	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given	Not Given
Sampling Date	11/11/2019	11/11/2019	11/11/2019
Sampling Time	Not Given	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water	Ground Water
Sampling Location	Not Given	Not Given	Not Given
Client Sample ID	Kormor Gawra-Spring / X-480842-Y-3886081	Taza Shaher -Spring / X-485378- Y-3882854	Sheikha Hammeed-Spring / X-486333-Y-3881433

Analyte	Units	Results	Results	Results	Method Limit of Detection
PAH's - Continued					
Fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Fluorene	µg/L	<0.01	<0.01	<0.01	0.01
Indeno(1,2,3-c,d)pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Naphthalene	µg/L	<0.02	<0.02	<0.02	0.02
Phenanthrene	µg/L	<0.01	<0.01	<0.01	0.01
Pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Pesticides - Organochlorine					
BHC alpha	µg/L	<0.1	<0.1	<0.1	0.1
BHC beta	µg/L	<0.1	<0.1	<0.1	0.1
BHC delta	µg/L	<0.1	<0.1	<0.1	0.1
BHC gamma (Lindane)	µg/L	<0.1	<0.1	<0.1	0.1
Chlordane	µg/L	<0.1	<0.1	<0.1	0.1
DDD-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
DDE-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
DDT-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan alpha	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan beta	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan sulphate	µg/L	<0.1	<0.1	<0.1	0.1
Endrin	µg/L	<0.1	<0.1	<0.1	0.1
Endrin aldehyde	µg/L	<0.1	<0.1	<0.1	0.1
Methoxychlor	µg/L	<0.1	<0.1	<0.1	0.1
Aldrin	µg/L	<0.03	<0.03	<0.03	0.03

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Analytical Report

Job Ref. No.	:	79957
Report No	:	111038
Date Reported :		25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

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002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-1	79957-2	79957-3
Date Received	16/12/2019	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given	Not Given
Sampling Date	11/11/2019	11/11/2019	11/11/2019
Sampling Time	Not Given	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water	Ground Water
Sampling Location	Not Given	Not Given	Not Given
Client Sample ID	Kormor Gawra-Spring / X-480842-Y-3886081	Taza Shaher -Spring / X-485378- Y-3882854	Sheikha Hammeed-Spring / X-486333-Y-3881433

Analyte	Units	Results	Results	Results	Method Limit of Detection
Pesticides - Organochlorine - Continued					
Dieldrin	µg/L	<0.03	<0.03	<0.03	0.03
Heptachlor	µg/L	<0.03	<0.03	<0.03	0.03
Heptachlor epoxide	µg/L	<0.03	<0.03	<0.03	0.03
Pesticides - Organophosphorous					
Chlorpyrifos	µg/L	<50	<50	<50	50
Dichlorvos	µg/L	<50	<50	<50	50
Dimethoate	µg/L	<50	<50	<50	50
Disulfoton	µg/L	<50	<50	<50	50
Fenchlorphos	µg/L	<50	<50	<50	50
Methyl Parathion	µg/L	<50	<50	<50	50
Parathion	µg/L	<50	<50	<50	50
Phorate	µg/L	<50	<50	<50	50
Famphur	µg/L	<50	<50	<50	50
Guthion	µg/L	<50	<50	<50	50
o,o,o-triethylphosphorothionate	µg/L	<50	<50	<50	50
Sulfotep	µg/L	<50	<50	<50	50
Thionazin	µg/L	<50	<50	<50	50
Tokuthion	µg/L	<50	<50	<50	50
Ethoprophos	µg/L	<50	<50	<50	50
Phenols					
Total Phenol	mg/L	<0.005	<0.005	<0.005	0.005

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Analytical Report

Job Ref. No. : 79957
Report No : 111038
Date Reported : 25/12/2019

Client: RSK ENVIRONMENT LLC – IRAQ BRANCH
Al Majal Business Park
Basrah, Iraq
BASRAH, IRAQ
Attn: Jessica Hommelhoff
Project ID: 182279/Water
Project Name: Crescent
Project Location: Kormor
Tel. No: +964 782 784 6339

Approved by:

002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID		79957-4	79957-5	79957-6	
Date Received		16/12/2019	16/12/2019	16/12/2019	
Sampled By		Not Given	Not Given	Not Given	
Sampling Date		11/11/2019	11/11/2019	11/11/2019	
Sampling Time		Not Given	Not Given	Not Given	
Sample Sub Matrix		Ground Water	Ground Water	Ground Water	
Sampling Location		Not Given	Not Given	Not Given	
Client Sample ID		SP-2 / X-486130- Y-3881866	SP-4 / X-489330- Y-3877453	GW-5 / X-487354- Y-3887512	
Analyte	**Units**	**Results**	**Results**	**Results**	**Method Limit of Detection**
Inorganic Parameters					
pH Value @ 20°C	pH units	7.9	7.9	7.9	-
Total Dissolved Solids	mg/L	341	228	444	5
Turbidity	NTU	0.7	0.3	4.3	0.1
Total Hardness	mg/L	185	178	218	1
Surfactants Anionic	mg/L	0.017	0.018	0.017	0.002
Anions					
Fluoride	mg/L	0.3	0.3	0.6	0.1
Nitrate	mg/L	0.58	1.24	1.86	0.04
Nitrite	mg/L	0.020	<0.016	0.259	0.016
Sulphate	mg/L	61.0	12.0	66.0	5
Chloride	mg/L	10.0	8.5	24.5	2
Metals					
Aluminium (Al)	mg/L	<0.01	<0.01	<0.01	0.01
Chromium (VI)	mg/L	<0.05	<0.05	<0.05	0.05
Arsenic (As)	mg/L	<0.01	<0.01	<0.01	0.01
Barium (Ba)	mg/L	0.13	0.04	0.09	0.01
Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	0.001
Calcium (Ca)	mg/L	62.6	62.9	51.2	0.1
Copper (Cu)	mg/L	<0.01	<0.01	<0.01	0.01
Iron (Fe)	mg/L	<0.01	<0.01	<0.01	0.01
Lead (Pb)	mg/L	<0.01	<0.01	<0.01	0.01
Magnesium (Mg)	mg/L	7.0	5.1	22.0	0.1

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Analytical Report

Job Ref. No. : 79957
Report No : 111038
Date Reported : 25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

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Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID		79957-4	79957-5	79957-6	
Date Received		16/12/2019	16/12/2019	16/12/2019	
Sampled By		Not Given	Not Given	Not Given	
Sampling Date		11/11/2019	11/11/2019	11/11/2019	
Sampling Time		Not Given	Not Given	Not Given	
Sample Sub Matrix		Ground Water	Ground Water	Ground Water	
Sampling Location		Not Given	Not Given	Not Given	
Client Sample ID		SP-2 / X-486130- Y-3881866	SP-4 / X-489330- Y-3877453	GW-5 / X-487354- Y-3887512	
Analyte	**Units**	**Results**	**Results**	**Results**	**Method Limit of Detection**
Metals - Continued					
Manganese (Mn)	mg/L	<0.01	<0.01	<0.01	0.01
Nickel (Ni)	mg/L	<0.01	<0.01	<0.01	0.01
Selenium (Se)	mg/L	<0.01	<0.01	<0.01	0.01
Sodium (Na)	mg/L	6.6	7.0	60.9	0.1
Zinc (Zn)	mg/L	<0.01	<0.01	<0.01	0.01
Mercury (Hg)	µg/L	<0.030	<0.030	<0.030	0.030
Hydrocarbons					
EPH C10-C40	µg/L	<50	<50	<50	50
VPH C5-C10	µg/L	<7	<7	<7	7
PAH's					
Acenaphthene	µg/L	<0.01	<0.01	<0.01	0.01
Acenaphthylene	µg/L	<0.01	<0.01	<0.01	0.01
Anthracene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(a)anthracene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(a)pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(b)fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(g,h,i)perylene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(k)fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Chrysene	µg/L	<0.01	<0.01	<0.01	0.01
Dibenzo(a,h)anthracene	µg/L	<0.01	<0.01	<0.01	0.01
Fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Fluorene	µg/L	<0.01	<0.01	<0.01	0.01

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Analytical Report

Job Ref. No. : 79957
Report No : 111038
Date Reported : 25/12/2019

Client: RSK ENVIRONMENT LLC – IRAQ BRANCH
Al Majal Business Park
Basrah, Iraq
BASRAH, IRAQ
Attn: Jessica Hommelhoff
Project ID: 182279/Water
Project Name: Crescent
Project Location: Kormor
Tel. No: +964 782 784 6339

Approved by:

002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID		79957-4	79957-5	79957-6	
Date Received		16/12/2019	16/12/2019	16/12/2019	
Sampled By		Not Given	Not Given	Not Given	
Sampling Date		11/11/2019	11/11/2019	11/11/2019	
Sampling Time		Not Given	Not Given	Not Given	
Sample Sub Matrix		Ground Water	Ground Water	Ground Water	
Sampling Location		Not Given	Not Given	Not Given	
Client Sample ID		SP-2 / X-486130- Y-3881866	SP-4 / X-489330- Y-3877453	GW-5 / X-487354- Y-3887512	
Analyte	**Units**	**Results**	**Results**	**Results**	**Method Limit of Detection**
PAH's - Continued					
Indeno(1,2,3-c,d)pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Naphthalene	µg/L	<0.02	0.04	<0.02	0.02
Phenanthrene	µg/L	<0.01	<0.01	<0.01	0.01
Pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Pesticides - Organochlorine					
BHC alpha	µg/L	<0.1	<0.1	<0.1	0.1
BHC beta	µg/L	<0.1	<0.1	<0.1	0.1
BHC delta	µg/L	<0.1	<0.1	<0.1	0.1
BHC gamma (Lindane)	µg/L	<0.1	<0.1	<0.1	0.1
Chlordane	µg/L	<0.1	<0.1	<0.1	0.1
DDD-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
DDE-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
DDT-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan alpha	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan beta	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan sulphate	µg/L	<0.1	<0.1	<0.1	0.1
Endrin	µg/L	<0.1	<0.1	<0.1	0.1
Endrin aldehyde	µg/L	<0.1	<0.1	<0.1	0.1
Methoxychlor	µg/L	<0.1	<0.1	<0.1	0.1
Aldrin	µg/L	<0.03	<0.03	<0.03	0.03
Dieldrin	µg/L	<0.03	<0.03	<0.03	0.03
Heptachlor	µg/L	<0.03	<0.03	<0.03	0.03

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Analytical Report

Job Ref. No.	:	79957
Report No	:	111038
Date Reported	:	25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-4	79957-5	79957-6
Date Received	16/12/2019	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given	Not Given
Sampling Date	11/11/2019	11/11/2019	11/11/2019
Sampling Time	Not Given	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water	Ground Water
Sampling Location	Not Given	Not Given	Not Given
Client Sample ID	SP-2 / X-486130- Y-3881866	SP-4 / X-489330- Y-3877453	GW-5 / X-487354- Y-3887512

Analyte	Units	Results	Results	Results	Method Limit of Detection
Pesticides - Organochlorine - Continued					
Heptachlor epoxide	µg/L	<0.03	<0.03	<0.03	0.03
Pesticides - Organophosphorous					
Chlorpyrifos	µg/L	<50	<50	<50	50
Dichlorvos	µg/L	<50	<50	<50	50
Dimethoate	µg/L	<50	<50	<50	50
Disulfoton	µg/L	<50	<50	<50	50
Fenchlorphos	µg/L	<50	<50	<50	50
Methyl Parathion	µg/L	<50	<50	<50	50
Parathion	µg/L	<50	<50	<50	50
Phorate	µg/L	<50	<50	<50	50
Famphur	µg/L	<50	<50	<50	50
Guthion	µg/L	<50	<50	<50	50
o,o,o-triethylphosphorothionate	µg/L	<50	<50	<50	50
Sulfotep	µg/L	<50	<50	<50	50
Thionazin	µg/L	<50	<50	<50	50
Tokuthion	µg/L	<50	<50	<50	50
Ethoprophos	µg/L	<50	<50	<50	50
Phenols					
Total Phenol	mg/L	<0.005	<0.005	<0.005	0.005

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Analytical Report

Job Ref. No.	:	79957
Report No	:	111038
Date Reported	:	25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

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Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-7	79957-8	79957-9
Date Received	16/12/2019	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given	Not Given
Sampling Date	11/11/2019	12/11/2019	12/11/2019
Sampling Time	Not Given	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water	Ground Water
Sampling Location	Not Given	Not Given	Not Given
Client Sample ID	SP-3	Zhazh-Spring / X-478101- Y-3889592	Takhta mina -Spring / X-484711- Y-387719

Analyte	Units	Results	Results	Results	Method Limit of Detection
Inorganic Parameters					
pH Value @ 20°C	pH units	8.0	7.9	7.7	-
Total Dissolved Solids	mg/L	337	1450	306	5
Turbidity	NTU	0.7	4.7	0.9	0.1
Total Hardness	mg/L	262	677	210	1
Surfactants Anionic	mg/L	0.016	0.017	0.015	0.002
Anions					
Fluoride	mg/L	0.2	0.7	0.4	0.1
Nitrate	mg/L	0.66	0.89	1.99	0.04
Nitrite	mg/L	0.016	0.168	0.016	0.016
Sulphate	mg/L	50.0	437	13.0	5
Chloride	mg/L	9.5	334	10.5	2
Metals					
Aluminium (Al)	mg/L	<0.01	<0.01	<0.01	0.01
Chromium (VI)	mg/L	<0.05	<0.05	<0.05	0.05
Arsenic (As)	mg/L	<0.01	<0.01	<0.01	0.01
Barium (Ba)	mg/L	0.13	0.05	0.27	0.01
Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	0.001
Calcium (Ca)	mg/L	93.4	180	64.4	0.1
Copper (Cu)	mg/L	<0.01	<0.01	<0.01	0.01
Iron (Fe)	mg/L	<0.01	<0.01	<0.01	0.01
Lead (Pb)	mg/L	<0.01	<0.01	<0.01	0.01

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Analytical Report

Job Ref. No.	:	79957
Report No	:	111038
Date Reported :		25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

مـركـز الإمـارات الـعـالـمـي للاعـتـمـاد
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Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID		79957-7	79957-8	79957-9	
Date Received		16/12/2019	16/12/2019	16/12/2019	
Sampled By		Not Given	Not Given	Not Given	
Sampling Date		11/11/2019	12/11/2019	12/11/2019	
Sampling Time		Not Given	Not Given	Not Given	
Sample Sub Matrix		Ground Water	Ground Water	Ground Water	
Sampling Location		Not Given	Not Given	Not Given	
Client Sample ID		SP-3	Zhazh-Spring / X-478101- Y-3889592	Takhta mina -Spring / X-484711- Y-387719	
Analyte	**Units**	**Results**	**Results**	**Results**	**Method Limit of Detection**
Metals - Continued					
Magnesium (Mg)	mg/L	7.1	55.1	11.9	0.1
Manganese (Mn)	mg/L	<0.01	<0.01	<0.01	0.01
Nickel (Ni)	mg/L	<0.01	<0.01	<0.01	0.01
Selenium (Se)	mg/L	<0.01	<0.01	<0.01	0.01
Sodium (Na)	mg/L	6.6	186	16.2	0.1
Zinc (Zn)	mg/L	<0.01	<0.01	<0.01	0.01
Mercury (Hg)	µg/L	<0.030	<0.030	<0.030	0.030
Hydrocarbons					
EPH C10-C40	µg/L	<50	<50	<50	50
VPH C5-C10	µg/L	<7	<7	<7	7
PAH's					
Acenaphthene	µg/L	<0.01	<0.01	<0.01	0.01
Acenaphthylene	µg/L	<0.01	<0.01	<0.01	0.01
Anthracene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(a)anthracene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(a)pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(b)fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(g,h,i)perylene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(k)fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Chrysene	µg/L	<0.01	<0.01	<0.01	0.01
Dibenzo(a,h)anthracene	µg/L	<0.01	<0.01	<0.01	0.01

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Analytical Report

Job Ref. No. : 79957
Report No : 111038
Date Reported : 25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

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Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-7	79957-8	79957-9
Date Received	16/12/2019	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given	Not Given
Sampling Date	11/11/2019	12/11/2019	12/11/2019
Sampling Time	Not Given	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water	Ground Water
Sampling Location	Not Given	Not Given	Not Given
Client Sample ID	SP-3	Zhazh-Spring / X-478101- Y-3889592	Takhta mina -Spring / X-484711- Y-387719

Analyte	Units	Results	Results	Results	Method Limit of Detection
PAH's - Continued					
Fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Fluorene	µg/L	<0.01	<0.01	<0.01	0.01
Indeno(1,2,3-c,d)pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Naphthalene	µg/L	<0.02	<0.02	<0.02	0.02
Phenanthrene	µg/L	<0.01	<0.01	<0.01	0.01
Pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Pesticides - Organochlorine					
BHC alpha	µg/L	<0.1	<0.1	<0.1	0.1
BHC beta	µg/L	<0.1	<0.1	<0.1	0.1
BHC delta	µg/L	<0.1	<0.1	<0.1	0.1
BHC gamma (Lindane)	µg/L	<0.1	<0.1	<0.1	0.1
Chlordane	µg/L	<0.1	<0.1	<0.1	0.1
DDD-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
DDE-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
DDT-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan alpha	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan beta	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan sulphate	µg/L	<0.1	<0.1	<0.1	0.1
Endrin	µg/L	<0.1	<0.1	<0.1	0.1
Endrin aldehyde	µg/L	<0.1	<0.1	<0.1	0.1
Methoxychlor	µg/L	<0.1	<0.1	<0.1	0.1
Aldrin	µg/L	<0.03	<0.03	<0.03	0.03

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Analytical Report

Job Ref. No. : 79957
Report No : 111038
Date Reported : 25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-7	79957-8	79957-9
Date Received	16/12/2019	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given	Not Given
Sampling Date	11/11/2019	12/11/2019	12/11/2019
Sampling Time	Not Given	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water	Ground Water
Sampling Location	Not Given	Not Given	Not Given
Client Sample ID	SP-3	Zhazh-Spring / X-478101- Y-3889592	Takhta mina -Spring / X-484711- Y-387719

Analyte	Units	Results	Results	Results	Method Limit of Detection
Pesticides - Organochlorine - Continued					
Dieldrin	µg/L	<0.03	<0.03	<0.03	0.03
Heptachlor	µg/L	<0.03	<0.03	<0.03	0.03
Heptachlor epoxide	µg/L	<0.03	<0.03	<0.03	0.03
Pesticides - Organophosphorous					
Chlorpyrifos	µg/L	<50	<50	<50	50
Dichlorvos	µg/L	<50	<50	<50	50
Dimethoate	µg/L	<50	<50	<50	50
Disulfoton	µg/L	<50	<50	<50	50
Fenchlorphos	µg/L	<50	<50	<50	50
Methyl Parathion	µg/L	<50	<50	<50	50
Parathion	µg/L	<50	<50	<50	50
Phorate	µg/L	<50	<50	<50	50
Famphur	µg/L	<50	<50	<50	50
Guthion	µg/L	<50	<50	<50	50
o,o,o-triethylphosphorothionate	µg/L	<50	<50	<50	50
Sulfotep	µg/L	<50	<50	<50	50
Thionazin	µg/L	<50	<50	<50	50
Tokuthion	µg/L	<50	<50	<50	50
Ethoprophos	µg/L	<50	<50	<50	50
Phenols					
Total Phenol	mg/L	<0.005	<0.005	<0.005	0.005

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Analytical Report

Job Ref. No. : 79957
Report No : 111038
Date Reported : 25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

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Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-10	79957-11	79957-12
Date Received	16/12/2019	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given	Not Given
Sampling Date	12/11/2019	13/11/2019	13/11/2019
Sampling Time	Not Given	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water	Ground Water
Sampling Location	Not Given	Not Given	Not Given
Client Sample ID	Ibrahim Ghulam-Spring / X-492210-Y-3887439	Paryawala Well / X-476313- Y-3892673 / 5.26m	WW-2 / X-481888-Y-3885416

Analyte	Units	Results	Results	Results	Method Limit of Detection
Inorganic Parameters					
pH Value @ 20°C	pH units	8.2	8.3	8.1	-
Total Dissolved Solids	mg/L	398	600	215	5
Turbidity	NTU	0.4	<0.1	<0.1	0.1
Total Hardness	mg/L	147	60.0	140	1
Surfactants Anionic	mg/L	0.017	0.016	0.015	0.002
Anions					
Fluoride	mg/L	0.9	1.0	0.5	0.1
Nitrate	mg/L	0.66	2.17	0.40	0.04
Nitrite	mg/L	0.016	0.023	0.020	0.016
Sulphate	mg/L	97.0	192	33.0	5
Chloride	mg/L	20.5	50.0	7.5	2
Metals					
Aluminium (Al)	mg/L	<0.01	<0.01	<0.01	0.01
Chromium (VI)	mg/L	<0.05	<0.05	<0.05	0.05
Arsenic (As)	mg/L	<0.01	<0.01	<0.01	0.01
Barium (Ba)	mg/L	0.05	0.02	0.16	0.01
Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	0.001
Calcium (Ca)	mg/L	29.1	14.0	43.0	0.1
Copper (Cu)	mg/L	<0.01	<0.01	<0.01	0.01
Iron (Fe)	mg/L	<0.01	<0.01	<0.01	0.01
Lead (Pb)	mg/L	<0.01	<0.01	<0.01	0.01

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Analytical Report

Job Ref. No.	:	79957
Report No	:	111038
Date Reported :		25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

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Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-10	79957-11	79957-12
Date Received	16/12/2019	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given	Not Given
Sampling Date	12/11/2019	13/11/2019	13/11/2019
Sampling Time	Not Given	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water	Ground Water
Sampling Location	Not Given	Not Given	Not Given
Client Sample ID	Ibrahim Ghulam-Spring / X-492210-Y-3887439	Paryawala Well / X-476313- Y-3892673 / 5.26m	WW-2 / X-481888-Y-3885416

Analyte	Units	Results	Results	Results	Method Limit of Detection
Metals - Continued					
Magnesium (Mg)	mg/L	18.5	6.5	7.8	0.1
Manganese (Mn)	mg/L	<0.01	<0.01	<0.01	0.01
Nickel (Ni)	mg/L	<0.01	<0.01	<0.01	0.01
Selenium (Se)	mg/L	<0.01	<0.01	<0.01	0.01
Sodium (Na)	mg/L	76.7	165	13.2	0.1
Zinc (Zn)	mg/L	<0.01	<0.01	<0.01	0.01
Mercury (Hg)	µg/L	<0.030	<0.030	<0.030	0.030
Hydrocarbons					
EPH C10-C40	µg/L	<50	<50	<50	50
VPH C5-C10	µg/L	<7	<7	<7	7
PAH's					
Acenaphthene	µg/L	<0.01	<0.01	<0.01	0.01
Acenaphthylene	µg/L	<0.01	<0.01	<0.01	0.01
Anthracene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(a)anthracene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(a)pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(b)fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(g,h,i)perylene	µg/L	<0.01	<0.01	<0.01	0.01
Benzo(k)fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Chrysene	µg/L	<0.01	<0.01	<0.01	0.01
Dibenzo(a,h)anthracene	µg/L	<0.01	<0.01	<0.01	0.01

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Analytical Report

Job Ref. No. : 79957
Report No : 111038
Date Reported : 25/12/2019

Client: RSK ENVIRONMENT LLC – IRAQ BRANCH
Al Majal Business Park
Basrah, Iraq
BASRAH, IRAQ
Attn: Jessica Hommelhoff
Project ID: 182279/Water
Project Name: Crescent
Project Location: Kormor
Tel. No: +964 782 784 6339

Approved by:
002-LB-TEST
Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-10	79957-11	79957-12	
Date Received	16/12/2019	16/12/2019	16/12/2019	
Sampled By	Not Given	Not Given	Not Given	
Sampling Date	12/11/2019	13/11/2019	13/11/2019	
Sampling Time	Not Given	Not Given	Not Given	
Sample Sub Matrix	Ground Water	Ground Water	Ground Water	
Sampling Location	Not Given	Not Given	Not Given	
Client Sample ID	Ibrahim Ghulam-Spring / X-492210-Y-3887439	Paryawala Well / X-476313- Y-3892673 / 5.26m	WW-2 / X-481888-Y-3885416	

Analyte	Units	Results	Results	Results	Method Limit of Detection
PAH's - Continued					
Fluoranthene	µg/L	<0.01	<0.01	<0.01	0.01
Fluorene	µg/L	<0.01	<0.01	<0.01	0.01
Indeno(1,2,3-c,d)pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Naphthalene	µg/L	<0.02	<0.02	<0.02	0.02
Phenanthrene	µg/L	<0.01	<0.01	<0.01	0.01
Pyrene	µg/L	<0.01	<0.01	<0.01	0.01
Pesticides - Organochlorine					
BHC alpha	µg/L	<0.1	<0.1	<0.1	0.1
BHC beta	µg/L	<0.1	<0.1	<0.1	0.1
BHC delta	µg/L	<0.1	<0.1	<0.1	0.1
BHC gamma (Lindane)	µg/L	<0.1	<0.1	<0.1	0.1
Chlordane	µg/L	<0.1	<0.1	<0.1	0.1
DDD-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
DDE-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
DDT-p,p'	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan alpha	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan beta	µg/L	<0.1	<0.1	<0.1	0.1
Endosulfan sulphate	µg/L	<0.1	<0.1	<0.1	0.1
Endrin	µg/L	<0.1	<0.1	<0.1	0.1
Endrin aldehyde	µg/L	<0.1	<0.1	<0.1	0.1
Methoxychlor	µg/L	<0.1	<0.1	<0.1	0.1
Aldrin	µg/L	<0.03	<0.03	<0.03	0.03

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Analytical Report

Job Ref. No.	:	79957
Report No	:	111038
Date Reported	:	25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-10	79957-11	79957-12
Date Received	16/12/2019	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given	Not Given
Sampling Date	12/11/2019	13/11/2019	13/11/2019
Sampling Time	Not Given	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water	Ground Water
Sampling Location	Not Given	Not Given	Not Given
Client Sample ID	Ibrahim Ghulam-Spring / X-492210-Y-3887439	Paryawala Well / X-476313- Y-3892673 / 5.26m	WW-2 / X-481888-Y-3885416

Analyte	Units	Results	Results	Results	Method Limit of Detection
Pesticides - Organochlorine - Continued					
Dieldrin	µg/L	<0.03	<0.03	<0.03	0.03
Heptachlor	µg/L	<0.03	<0.03	<0.03	0.03
Heptachlor epoxide	µg/L	<0.03	<0.03	<0.03	0.03
Pesticides - Organophosphorous					
Chlorpyrifos	µg/L	<50	<50	<50	50
Dichlorvos	µg/L	<50	<50	<50	50
Dimethoate	µg/L	<50	<50	<50	50
Disulfoton	µg/L	<50	<50	<50	50
Fenchlorphos	µg/L	<50	<50	<50	50
Methyl Parathion	µg/L	<50	<50	<50	50
Parathion	µg/L	<50	<50	<50	50
Phorate	µg/L	<50	<50	<50	50
Famphur	µg/L	<50	<50	<50	50
Guthion	µg/L	<50	<50	<50	50
o,o,o-triethylphosphorothionate	µg/L	<50	<50	<50	50
Sulfotep	µg/L	<50	<50	<50	50
Thionazin	µg/L	<50	<50	<50	50
Tokuthion	µg/L	<50	<50	<50	50
Ethoprophos	µg/L	<50	<50	<50	50
Phenols					
Total Phenol	mg/L	<0.005	<0.005	<0.005	0.005

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Analytical Report

Job Ref. No. : 79957
Report No : 111038
Date Reported : 25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

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Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-13	79957-14
Date Received	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given
Sampling Date	13/11/2019	13/11/2019
Sampling Time	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water
Sampling Location	Not Given	Not Given
Client Sample ID	WW-3 / X-482156-Y-3884612	WW-6

Analyte	Units	Results	Results	Results	Method Limit of Detection
Inorganic Parameters					
pH Value @ 20°C	pH units	8.1	7.9		-
Total Dissolved Solids	mg/L	203	215		5
Turbidity	NTU	<0.1	0.7		0.1
Total Hardness	mg/L	134	141		1
Surfactants Anionic	mg/L	0.016	0.017		0.002
Anions					
Fluoride	mg/L	0.4	0.6		0.1
Nitrate	mg/L	0.71	0.18		0.04
Nitrite	mg/L	<0.016	0.020		0.016
Sulphate	mg/L	24.0	36.0		5
Chloride	mg/L	7.0	8.0		2
Metals					
Aluminium (Al)	mg/L	<0.01	<0.01		0.01
Chromium (VI)	mg/L	<0.05	<0.05		0.05
Arsenic (As)	mg/L	<0.01	<0.01		0.01
Barium (Ba)	mg/L	0.21	0.14		0.01
Cadmium (Cd)	mg/L	<0.001	<0.001		0.001
Calcium (Ca)	mg/L	42.0	43.0		0.1
Copper (Cu)	mg/L	<0.01	<0.01		0.01
Iron (Fe)	mg/L	<0.01	<0.01		0.01
Lead (Pb)	mg/L	<0.01	<0.01		0.01
Magnesium (Mg)	mg/L	7.1	8.3		0.1

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Analytical Report

Job Ref. No. : 79957
Report No : 111038
Date Reported : 25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

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Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-13	79957-14
Date Received	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given
Sampling Date	13/11/2019	13/11/2019
Sampling Time	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water
Sampling Location	Not Given	Not Given
Client Sample ID	WW-3 / X-482156-Y-3884612	WW-6

Analyte	Units	Results	Results	Results	Method Limit of Detection
Metals - Continued					
Manganese (Mn)	mg/L	<0.01	<0.01		0.01
Nickel (Ni)	mg/L	<0.01	<0.01		0.01
Selenium (Se)	mg/L	<0.01	<0.01		0.01
Sodium (Na)	mg/L	12.2	14.4		0.1
Zinc (Zn)	mg/L	<0.01	<0.01		0.01
Mercury (Hg)	µg/L	<0.030	<0.030		0.030
Hydrocarbons					
EPH C10-C40	µg/L	<50	<50		50
VPH C5-C10	µg/L	<7	<7		7
PAH's					
Acenaphthene	µg/L	<0.01	<0.01		0.01
Acenaphthylene	µg/L	<0.01	<0.01		0.01
Anthracene	µg/L	<0.01	<0.01		0.01
Benzo(a)anthracene	µg/L	<0.01	<0.01		0.01
Benzo(a)pyrene	µg/L	<0.01	<0.01		0.01
Benzo(b)fluoranthene	µg/L	<0.01	<0.01		0.01
Benzo(g,h,i)perylene	µg/L	<0.01	<0.01		0.01
Benzo(k)fluoranthene	µg/L	<0.01	<0.01		0.01
Chrysene	µg/L	<0.01	<0.01		0.01
Dibenzo(a,h)anthracene	µg/L	<0.01	<0.01		0.01
Fluoranthene	µg/L	<0.01	<0.01		0.01
Fluorene	µg/L	<0.01	<0.01		0.01

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Analytical Report

Job Ref. No. :	79957
Report No :	111038
Date Reported :	25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

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Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-13	79957-14
Date Received	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given
Sampling Date	13/11/2019	13/11/2019
Sampling Time	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water
Sampling Location	Not Given	Not Given
Client Sample ID	WW-3 / X-482156-Y-3884612	WW-6

Analyte	Units	Results	Results	Results	Method Limit of Detection
PAH's - Continued					
Indeno(1,2,3-c,d)pyrene	µg/L	<0.01	<0.01		0.01
Naphthalene	µg/L	<0.02	<0.02		0.02
Phenanthrene	µg/L	<0.01	<0.01		0.01
Pyrene	µg/L	<0.01	<0.01		0.01
Pesticides - Organochlorine					
BHC alpha	µg/L	<0.1	<0.1		0.1
BHC beta	µg/L	<0.1	<0.1		0.1
BHC delta	µg/L	<0.1	<0.1		0.1
BHC gamma (Lindane)	µg/L	<0.1	<0.1		0.1
Chlordane	µg/L	<0.1	<0.1		0.1
DDD-p,p'	µg/L	<0.1	<0.1		0.1
DDE-p,p'	µg/L	<0.1	<0.1		0.1
DDT-p,p'	µg/L	<0.1	<0.1		0.1
Endosulfan alpha	µg/L	<0.1	<0.1		0.1
Endosulfan beta	µg/L	<0.1	<0.1		0.1
Endosulfan sulphate	µg/L	<0.1	<0.1		0.1
Endrin	µg/L	<0.1	<0.1		0.1
Endrin aldehyde	µg/L	<0.1	<0.1		0.1
Methoxychlor	µg/L	<0.1	<0.1		0.1
Aldrin	µg/L	<0.03	<0.03		0.03
Dieldrin	µg/L	<0.03	<0.03		0.03
Heptachlor	µg/L	<0.03	<0.03		0.03

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Analytical Report

Job Ref. No.	:	79957
Report No	:	111038
Date Reported :		25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Sample ID	79957-13	79957-14
Date Received	16/12/2019	16/12/2019
Sampled By	Not Given	Not Given
Sampling Date	13/11/2019	13/11/2019
Sampling Time	Not Given	Not Given
Sample Sub Matrix	Ground Water	Ground Water
Sampling Location	Not Given	Not Given
Client Sample ID	WW-3 / X-482156-Y-3884612	WW-6

Analyte	Units	Results	Results	Results	Method Limit of Detection
Pesticides - Organochlorine - Continued					
Heptachlor epoxide	µg/L	<0.03	<0.03		0.03
Pesticides - Organophosphorous					
Chlorpyrifos	µg/L	<50	<50		50
Dichlorvos	µg/L	<50	<50		50
Dimethoate	µg/L	<50	<50		50
Disulfoton	µg/L	<50	<50		50
Fenchlorphos	µg/L	<50	<50		50
Methyl Parathion	µg/L	<50	<50		50
Parathion	µg/L	<50	<50		50
Phorate	µg/L	<50	<50		50
Famphur	µg/L	<50	<50		50
Guthion	µg/L	<50	<50		50
o,o,o-triethylphosphorothionate	µg/L	<50	<50		50
Sulfotep	µg/L	<50	<50		50
Thionazin	µg/L	<50	<50		50
Tokuthion	µg/L	<50	<50		50
Ethoprophos	µg/L	<50	<50		50
Phenols					
Total Phenol	mg/L	<0.005	<0.005		0.005

Method of Analysis

Method Name	Reference
Chloride [APHA 4500 Cl- B]-DXB	APHA [4500 Cl- B]

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Analytical Report

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Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

002-LB-TEST

Saji SK

Asst. Laboratory Manager–Chemistry & Microbiology

Method of Analysis

Method Name	Reference
Chromium (Hexavalent) [HACH 8023] Water-DXB	HACH [8023]
EPH C10-C40 by GC-FID [EPA 8015B] Water-DXB$	EPA [8015B]
Fluoride [HACH 8029]-DXB	HACH [8029]
Hardness (Total) [APHA 2340 B]-DXB	APHA [2340 B]
Mercury by PSA [EPA 245.7] P&E-DXB$	EPA [245.7]
Metals ICP OES [APHA 3120 B] P-DXB$	APHA [3120 B]
Nitrate [HACH 8039]-DXB	HACH [8039]
Nitrite [HACH 8507]-DXB	HACH [8507]
Organochlorine Pesticides in Water [EPA 8081 A]-DXB$	EPA [8081 A]
Organophosphorous Pesticides in water [EPA 8270 D]-DXB	EPA [8270 D]
PAH in Water [EPA 8270 D]-DXB$	US EPA [8270 D]
pH [APHA 4500 H+ B]Water-DXB$	APHA [4500 H+ B]
Phenol (Total) [HACH 8047]-DXB	HACH [8047]
Solids (Total Dissolved) [APHA 2540 C]Water-DXB$	APHA [2540 C]
Sulphate [APHA 4500 SO42- C]-DXB	APHA [4500 SO42- C]
Surfactants Anionic [HACH 8028]-DXB	HACH [8028]
Turbidity [APHA 2130 B]-DXB	APHA [2130 B]
VPH C5-C10 by GC-FID [EPA 8015B]-Water-DXB$	EPA [8015B]

* Reference Method Modified

Comments:

- Tested By : AAP, JCH, SKR, SMO
- Date Tested: 19/12/2019 to 24/12/2019

. Please note that if the sample has to be diluted due to the matrix, the reported Limit of Detection (LOD) value will increase from the method LOD.

. Any APHA methods stated herein are documented in-house procedures, referenced to 23rd edition.

. Test methods marked with $ are EIAC (formerly DAC) accredited.

. Please note that the metals results reported above are dissolved metals.

. Please see the table below detailing the surrogate recovery of Naphthalene-D8* for the samples shown. The normal acceptable recovery range is 70-130%, however, the values shown are slightly below this for some of the samples due to the sample matrix effect. The recovery of the counterpart analytes may therefore also be slightly reduced. All other surrogate compounds had acceptable recovery.

Surrogate Compounds	79957/1	79957/2	79957/4	79957/5	79957/6	79957/7	79957/8	79957/9	79957/10	79957/12	79957/13	79957/14
Naphthalene-D8*	72	75	65	74	72	70	70	71	73	75	66	66

70 74

Al Futtaim Element Materials Technology Dubai L.L.C
Plot 598-221, Dubai Investments Park,
P.O. Box 34924
Dubai, United Arab Emirates

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me.dxbnorlims@element.com
element.com

Analytical Report

Job Ref. No.	:	79957
Report No	:	111038
Date Reported :		25/12/2019

Client:	RSK ENVIRONMENT LLC – IRAQ BRANCH Al Majal Business Park Basrah, Iraq BASRAH, IRAQ
Attn:	Jessica Hommelhoff
Project ID:	182279/Water
Project Name:	Crescent
Project Location:	Kormor
Tel. No:	+964 782 784 6339

Approved by:

مـركـز الإمـارات الـعـالـمـي للاعـتـمـاد
Emirates International Accreditation Centre
002-LB-TEST

Saji SK
Asst. Laboratory Manager–Chemistry & Microbiology

Water sampling bacterial laboratory results:

Al Majal Business Park
Berjessah, Az Zubayr, Basra

FINAL ANALYTICAL TEST REPORT

Laboratory Job Number:	19/10710	
Issue Number:	1	**Date:** 16 November, 2019

Client:	RSK Environment IIc, Iraq PO Box 45103 Abu Dhabi 902 Silver Wave Tower Suite 1202 Mina Road Abu Dhabi United Arab Emirates
Project Manager:	Jessica Hommelhoff
Project Name:	Crescent
Project Ref:	182279
Order No:	N/A
Date Samples Received:	12/11/19
Date Instructions Received:	12/11/19
Date Analysis Completed:	16/11/19

Prepared by:	**Approved by:**
Farhan Shaher Luhaib Senior Technician	Hayder Naseer Laboratory Supervisor

Laboratory Iraq

Laboratory Job Number: 19/10710 **Client Project Name:** Crescent

Client Project Ref: 182279

Lab Sample ID	19/10710/1	19/10710/2	19/10710/3	19/10710/4	19/10710/5	19/10710/6	19/10710/7	Units	Limit of Detection	Method ref
Client Sample No	Kormor Gawra-Spring	Taza Shaher-Spring	Sheikh Hameed-Spring	SP-2	SP-4	GW-5	SP-3			
Client Sample ID	480842-3886081	485378-3882854	486333-3881433	486130-3881866	489330-3877453	487354-3887512				
Depth to Top										
Depth To Bottom										
Date Sampled	11-Nov-19	11-Nov-19	11-Nov-19	11-Nov-19	11-Nov-19	11-Nov-19	11-Nov-19			
Sample Type	Water - W	Water - W	Water - W	Water - W	Water - W	Water - W	Water - W			
Ecoli$_A$	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth			Test kit
Coliforms (total)$_A$	1000	100000	100	100	100	100000	1000	cfu/ml		Test kit

REPORT NOTES

Notes - Soil analysis
All results are reported as dry weight.
Natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis.

Notes - General

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Samples submitted by others. Sampling is outside of our control.

Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.
For samples that are oil all analysis is performed on the as received sample and this supercedes any "D" subscript.
For samples that are aggregate, stones, concrete or any similar matrices all analysis is performed on the dried and crushed sample.

Uncertainty has been calculated for all procedures and summary data is available upon request.
All calibrations performed by the laboratory are traceable to NIST standards.

IS indicates Insufficient sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
Superscript * indicates that all analysis for that sample was performed by a subcontract laboratory.
Superscript # indicates method accredited to ISO 17025.
Analytical results reflect the quality of the sample at the time of analysis only. Opinions and interpretations expressed are outside the scope of our accreditation.

Please contact us if you need any further information.

Al Majal Business Park
Berjessah, Az Zubayr, Basra

FINAL ANALYTICAL TEST REPORT

Laboratory Job Number: 19/10723
Issue Number: 1 **Date:** 16 November, 2019

Client: RSK Environment IIc, Iraq
PO Box 45103 Abu Dhabi
902 Silver Wave Tower
Suite 1202
Mina Road
Abu Dhabi
United Arab Emirates

Project Manager: Jessica Hommelhoff
Project Name: Crescent
Project Ref: 182279
Order No: N/A
Date Samples Received: 13/11/19
Date Instructions Received: 13/11/19
Date Analysis Completed: 16/11/19

Prepared by:

Farhan Shaher Luhaib
Senior Technician

Approved by:

Hayder Naseer
Laboratory Supervisor

Laboratory Job Number: 19/10723 Client Project Name: Crescent

Client Project Ref: 182279

Lab Sample ID	19/10723/1	19/10723/2	19/10723/3					Units	Limit of Detection	Method ref
Client Sample No	Zhazh-Spring	Takhta mina-Spring	Ibrahim Ghulam-Sprin							
Client Sample ID	478101-3889592	484711-387719	492210-3887439							
Depth to Top										
Depth To Bottom										
Date Sampled	12-Nov-19	12-Nov-19	12-Nov-19							
Sample Type	Water - W	Water - W	Water - W							
Ecoli A	No Growth	No Growth	No Growth							Test kit
Coliforms (total) A	10000	100000	10000					cfu/ml		Test kit

REPORT NOTES

Notes - Soil analysis
All results are reported as dry weight.
Natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis.

Notes - General

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For samples that are oil all analysis is performed on the as received sample and this supercedes any “D” subscript.
For samples that are aggregate, stones, concrete or any similar matrices all analysis is performed on the dried and crushed sample.

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All calibrations performed by the laboratory are traceable to NIST standards.

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Al Majal Business Park
Berjessah, Az Zubayr, Basra

FINAL ANALYTICAL TEST REPORT

Laboratory Job Number: 19/10883
Issue Number: 1 **Date:** 16 November, 2019

Client: RSK Environment llc, Iraq
PO Box 45103 Abu Dhabi
902 Silver Wave Tower
Suite 1202
Mina Road
Abu Dhabi
United Arab Emirates

Project Manager: Jessica Hommelhoff
Project Name: Crescent
Project Ref: 182279
Order No: N/A
Date Samples Received: 14/11/19
Date Instructions Received: 14/11/19
Date Analysis Completed: 16/11/19

Prepared by:

Farhan Shaher Luhaib
Senior Technician

Approved by:

Hayder Naseer
Laboratory Supervisor

Laboratory Job Number: 19/10883

Client Project Name: Crescent

Client Project Ref: 182279

Lab Sample ID	19/10883/1	19/10883/2	19/10883/3	19/10883/4				Units	Limit of Detection	Method ref
Client Sample No	Paryawla well	WW-2	WW-3	WW-6						
Client Sample ID	476313-3892673	481888-3885416	482156-3884612							
Depth to Top	5.26									
Depth To Bottom										
Date Sampled	13-Nov-19	13-Nov-19	13-Nov-19	13-Nov-19						
Sample Type	Water - W	Water - W	Water - W	Water - W						
Ecoli$_A$	No Growth	No Growth	No Growth	No Growth						Test kit
Coliforms (total)$_A$	10	10	10	100				cfu/ml		Test kit

REPORT NOTES

Notes - Soil analysis
All results are reported as dry weight.
Natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis.

Notes - General

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For samples that are oil all analysis is performed on the as received sample and this supercedes any "D" subscript.
For samples that are aggregate, stones, concrete or any similar matrices all analysis is performed on the dried and crushed sample.

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AIR

Air quality laboratory results:

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ilac-MRA UKAS TESTING 2187

LABORATORY ANALYSIS REPORT

HYDROGEN SULPHIDE IN DIFFUSION TUBES BY U.V.SPECTROPHOTOMETRY

REPORT NUMBER N07476R

BOOKING IN REFERENCE N07476
DESPATCH NOTE 73775
CUSTOMER RSK Environment Llc (UAE) Attn: Andreea Stroe
PO Box 46112
Al Ghaith Tower, Suite 1202
Hamdan Bin Mohamed St.
Abu Dhabi

United Arab Emirates

DATE SAMPLES RECEIVED 10/10/2019

JOB NUMBER

Location	Sample Number	Exposure Data Date On*	Date Off*	Time* (hr.)	µg H_2S on tube	µg H_2S - Blank	µg/m^3 *	ppb *
Kormar Gamara Village	1431399	22/08/2019	23/09/2019	764.67	0.08	0.04	0.08	0.06
Kormar Bichuck Village	1431394	20/08/2019	23/09/2019	815.50	<0.04	<0.01	<0.01	<0.01
Taza Shahaw Village	1431395	20/08/2019	23/09/2019	814.83	<0.04	<0.01	<0.01	<0.01
Aweya Jalal Village	1431397	21/08/2019	23/09/2019	790.33	0.06	0.02	0.04	0.02
Shikhhsmeed Village	1431396	21/08/2019	23/09/2019	792.75	0.05	0.01	0.01	0.01
Mamsik Village	1431401	24/08/2019	23/09/2019	726.33	<0.04	<0.01	<0.01	<0.01
Qadev Qarm Village	1431398	22/08/2019	23/09/2019	774.58	0.05	0.02	0.03	0.02
MP8	1431400	23/08/2019	23/09/2019	746.00	<0.04	<0.01	<0.01	<0.01
Field Blank	1431402				0.04			
Laboratory Blank					0.02			

Results reported as <0.044µg on tube are below the reporting limit.
Tubes have exceeded shelf-life. Results may be compromised.

Overall M.U. ±18.6% **Limit of Detection** 0.044µg on tube

Analysed on CARY 60
Analyst Name Sam Minns **Report Checked By** Andrew Poole

Date of Analysis 15/10/2019 **Date of Report** 22/10/2019

Analysis carried out in accordance with documented in-house Laboratory Method GLM5

REPORT OFFICIALLY CHECKED

Gradko International Ltd
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Signed...
L. Gates, Laboratory Manager

gradko environmental
(A division of Gradko International Ltd.)
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LABORATORY ANALYSIS REPORT

Report Number	**N07442R**
Customer	**RSK Environment LLC (UAE)** **PO Box 46112** **Al Ghaith Tower, Suite 1202** **Hamdan Bin Mohamed St.** **Abu Dhabi, UAE**
Booking In Reference	**T1299**
Despatch Note Number	**73775**
Date Samples Received	**10/10/2019**
Diffusion Tube Type	**Tenax**

Quantitative Analysis of BTEX
Identification and estimation of ng on tube in accordance with ISO16000-6
Estimation of Total VOC (C_6 to C_{16}) on Tenax Diffusion Tubes in accordance with ISO16000-6

Tube Number	**GRA02624**
Gradko Lab Reference	**04N1310**
Exposure Time (mins)*	**45880**
Sample ID	**Kormor Gawra Village**

BTEX	**ng on tube**	**ppb in air***	**µgm^{-3}***
Benzene	5.6	0.2	0.5
Toluene	6.6	0.1	0.5
Ethylbenzene	<5.0	<0.1	<0.3
m/p-Xylene	<5.0	<0.1	<0.3
o-Xylene	<5.0	<0.1	<0.3

Top 5 VOC	**Estimated ng on tube**	**ppb in air***	**µgm^{-3}***
Benzoic acid	617	6.7	33
2,6-Diphenyl-p-benzoquinone	338	3.7	38
Acetophenone**	79	0.9	4.1
Phenylmaleic anhydride	67	0.7	5.1
Benzaldehyde**	61	0.7	2.8

	Estimated ng on tube	**ppb in air***	**µgm^{-3}***
Total VOC (C_6 to C_{16})	1097	12.0	74.4

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LABORATORY ANALYSIS REPORT

Tube Number	**001685**
Gradko Lab Reference	**04N1311**
Exposure Time (mins)*	**48930**
Sample ID	**Kormor Bichuk Village**

BTEX	ng on tube	ppb in air*	μgm^{-3}*
Benzene	5.0	0.1	0.5
Toluene	<5.0	<0.1	<0.4
Ethylbenzene	<5.0	<0.1	<0.3
m/p-Xylene	<5.0	<0.1	<0.3
o-Xylene	<5.0	<0.1	<0.3

Top 5 VOC	Estimated ng on tube	ppb in air*	μgm^{-3}*
Benzoic acid	924	9.4	46
2,6-Diphenyl-p-benzoquinone	339	3.5	36
Acetophenone**	112	1.1	5.5
Phenylmaleic anhydride	98	1.0	7.0
Benzaldehyde**	79	0.8	3.4

	Estimated ng on tube	ppb in air*	μgm^{-3}*
Total VOC (C_6 to C_{16})	1804	18.4	117

Tube Number	**GRA09924**
Gradko Lab Reference	**04N1312**
Exposure Time (mins)*	**48890**
Sample ID	**Taza Shahar Village**

BTEX	ng on tube	ppb in air*	μgm^{-3}*
Benzene	5.6	0.2	0.5
Toluene	<5.0	<0.1	<0.4
Ethylbenzene	<5.0	<0.1	<0.3
m/p-Xylene	<5.0	<0.1	<0.3
o-Xylene	<5.0	<0.1	<0.3

Top 5 VOC	Estimated ng on tube	ppb in air*	μgm^{-3}*
Benzoic acid	1204	12	60
2,6-Diphenyl-p-benzoquinone	296	3.0	31
2-Phenacyl-quinoxaline	193	2.0	20
Acetophenone**	139	1.4	6.8
Phenylmaleic anhydride	134	1.4	9.5

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LABORATORY ANALYSIS REPORT

	Estimated ng on tube	ppb in air*	µgm^{-3}*
Total VOC (C_6 to C_{16})	2042	20.9	133

Tube Number GRA10201
Gradko Lab Reference 04N1313
Exposure Time (mins)* 47420
Sample ID Awey el Talal Village

BTEX	ng on tube	ppb in air*	µgm^{-3}*
Benzene	5.5	0.2	0.5
Toluene	<5.0	<0.1	<0.4
Ethylbenzene	<5.0	<0.1	<0.3
m/p-Xylene	<5.0	<0.1	<0.3
o-Xylene	<5.0	<0.1	<0.3

Top 5 VOC	Estimated ng on tube	ppb in air*	µgm^{-3}*
Benzoic acid	963	10.2	49.6
2,6-Diphenyl-p-benzoquinone	281	3.0	31
2-Phenacyl-quinoxaline	158	1.7	17
Acetophenone**	118	1.2	6.0
Phenylmaleic anhydride	102	1.1	7.5

	Estimated ng on tube	ppb in air*	µgm^{-3}*
Total VOC (C_6 to C_{16})	1706	18.0	114

Tube Number GRA08280
Gradko Lab Reference 04N1314
Exposure Time (mins)* 47565
Sample ID Shehik Hanced Village

BTEX	ng on tube	ppb in air*	µgm^{-3}*
Benzene	6.0	0.2	0.6
Toluene	6.2	0.1	0.5
Ethylbenzene	<5.0	<0.1	<0.3
m/p-Xylene	5.1	0.1	0.3
o-Xylene	<5.0	<0.1	<0.3

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LABORATORY ANALYSIS REPORT

Top 5 VOC	Estimated ng on tube	ppb in air*	µgm-3*
Benzoic acid	1019	11	52
2,6-Diphenyl-p-benzoquinone	239	2.5	26
Acetophenone**	112	1.2	5.7
Phenylmaleic anhydride	108	1.1	7.9
Benzaldehyde**	82	0.9	3.7

	Estimated ng on tube	ppb in air*	µgm-3*
Total VOC (C_6 to C_{16})	1801	18.9	120

Tube Number	**GRA09570**
Gradko Lab Reference	**04N1315**
Exposure Time (mins)*	**43580**
Sample ID	**Mamsik Village**

BTEX	ng on tube	ppb in air*	µgm-3*
Benzene	5.4	0.2	0.6
Toluene	12.2	0.3	1.0
Ethylbenzene	<5.0	<0.1	<0.3
m/p-Xylene	10.2	0.2	0.7
o-Xylene	<5.0	<0.1	<0.3

Top 5 VOC	Estimated ng on tube	ppb in air*	µgm-3*
Benzoic acid	678	7.8	38
2,6-Diphenyl-p-benzoquinone	212	2.4	25
Nonanal**	128	1.5	8.3
Acetophenone**	89	1.0	4.9
Phenylmaleic anhydride	70	0.8	5.6

	Estimated ng on tube	ppb in air*	µgm-3*
Total VOC (C_6 to C_{16})	1579	18.1	113

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LABORATORY ANALYSIS REPORT

Tube Number	**GRA04440**
Gradko Lab Reference	**04N1316**
Exposure Time (mins)*	**46475**
Sample ID	**Qader Karam Village**

BTEX	ng on tube	ppb in air*	µgm^{-3}*
Benzene	<5.0	<0.2	<0.5
Toluene	<5.0	<0.1	<0.4
Ethylbenzene	<5.0	<0.1	<0.3
m/p-Xylene	<5.0	<0.1	<0.3
o-Xylene	<5.0	<0.1	<0.3

Top 5 VOC	Estimated ng on tube	ppb in air*	µgm^{-3}*
Benzoic acid	614	6.6	32
2,6-Diphenyl-p-benzoquinone	222	2.4	25
Acetophenone**	92	1.0	4.7
Benzaldehyde**	56	0.6	2.5
Phenylmaleic anhydride	53	0.6	4.0

	Estimated ng on tube	ppb in air*	µgm^{-3}*
Total VOC (C_6 to C_{16})	1094	11.8	73.6

Tube Number	**GRA10309**
Gradko Lab Reference	**04N1317**
Exposure Time (mins)*	**44760**
Sample ID	**MP8**

BTEX	ng on tube	ppb in air*	µgm^{-3}*
Benzene	6.8	0.2	0.7
Toluene	11.1	0.2	0.9
Ethylbenzene	<5.0	<0.1	<0.3
m/p-Xylene	7.2	0.1	0.5
o-Xylene	<5.0	<0.1	<0.3

Top 5 VOC	Estimated ng on tube	ppb in air*	µgm^{-3}*
Benzoic acid	458	5.1	25
2,6-Diphenyl-p-benzoquinone	422	4.7	49
Acetophenone**	80	0.9	4.3
Benzaldehyde**	63	0.7	3.0
Phenylmaleic anhydride	57	0.6	4.4

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tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

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LABORATORY ANALYSIS REPORT

	Estimated ng on tube	ppb in air*	μgm^{-3}*
Total VOC (C_6 to C_{16})	1462	16.3	101

Tube Number	**GRA06147**
Gradko Lab Reference	**04N1318**
Exposure Time (mins)*	**49440**
Sample ID	**Field Blank**

BTEX	ng on tube	ppb in air*	μgm^{-3}*
Benzene	<5.0	<0.1	<0.5
Toluene	<5.0	<0.1	<0.4
Ethylbenzene	<5.0	<0.1	<0.3
m/p-Xylene	<5.0	<0.1	<0.3
o-Xylene	<5.0	<0.1	<0.3

Top 5 VOC	Estimated ng on tube	ppb in air*	μgm^{-3}*
Phthalic acid, isoporpyl propyl ester	6	0.1	0.6

1 Compound detected

	Estimated ng on tube
Total VOC (C_6 to C_{16})	<5

Results are not Blank corrected.
Overall MU ±17.8% for quantitative analysis of BTEX compounds.
Estimated results as ng on tube are calculated by reference to toluene in accordance with ISO 16000-6
Results for Total VOC as μgm^{-3} are calculated by reference to alkane molecular weights.

Results greater than 1000ng (excluding Total VOC results) are outside of our UKAS accredited calibration range.

Results reported as <5ng on tube are below the reporting limit.
Reporting limits for BTEX 5ng
Estimated results reported as <5ng on tube are below the reporting limit for the non-specific standard toluene.

2,6-Diphenyl-p-benzoquinone is not present in mass spectrum libraries. It has been tentatively identified by comparison of the mass spectrum and retention times of the standard 2,5-Diphenyl-p-benzoquinone.
2,6-Diphenyl-p-benzoquinone may be an artifact due to degradation of Tenax by nitrogen dioxide.

REPORT OFFICIALLY CHECKED

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LABORATORY ANALYSIS REPORT

Compounds shown in italics are tentatively identified due to quality match of less than 85%

****Compounds may be an artifact due to reaction of ozone with the Tenax sorbent.**

Uptake Rates:
Benzene 0.70 ng.ppm^{-1}.min^{-1}.
Toluene 1.03 ng.ppm^{-1}.min^{-1}.
Ethylbenzene 1.46 ng.ppm^{-1}.min^{-1}.
m/p Xylene 1.46 ng.ppm^{-1}.min^{-1}.
o-Xylene 1.46 ng.ppm^{-1}.min^{-1}.
All other compounds: 2.00 ng.ppm^{-1}.min^{-1}.

Analysts Name	**Katya Paldamova**	**Date of Analysis**	**21/10/2019**
Report Checked By	**Mariella Angelova**	**Date of Report**	**31/10/2019**

Analysis has been carried out in accordance with in-house method GLM 13

REPORT OFFICIALLY CHECKED

Gradko International Ltd
This signature confirms the authenticity of these results
Signed...
L. Gates, Laboratory Manager

gradko environmental
(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

2187

LABORATORY ANALYSIS REPORT

DETERMINATION OF SULPHUR DIOXIDE IN DIFFUSION TUBES BY ION CHROMATOGRAPHY

REPORT NUMBER N07593R

BOOKING IN REFERENCE No N07593

DESPATCH NOTE No 73775

CUSTOMER RSK Environment Llc (UAE) Attn: Andreea Stroe
PO Box 46112
Al Ghaith Tower, Suite 1202
Hamdan Bin Mohamed St.
Abu Dhabi

United Arab Emirates

DATE SAMPLES RECEIVED 10/10/2019

JOB NUMBER

Location	Sample Number	Date Exposed*	Date Finished*	Exposure Hours*	SO_4^{2-} µg/ml	µgSO_4^{2-} - Blank	SO_2 µg/m^3*	SO_2 ppb*
Kormar Gamara Village	1431383	22/08/2019	23/09/2019	764.67	0.82	0.73	11.66	4.37
Kormar Bichuck Village	1431374	20/08/2019	23/09/2019	815.50	1.77	1.69	25.25	9.47
Taza Shaher Village	1431375	20/08/2019	23/09/2019	814.83	1.55	1.46	21.87	8.20
Aweya Jalal Village	1431377	21/08/2019	23/09/2019	790.33	1.61	1.53	23.54	8.83
Shikh Hameed Village	1431376	21/08/2019	23/09/2019	792.75	1.30	1.21	18.64	6.99
Mamsik Village	1431381	24/08/2019	23/09/2019	726.33	0.85	0.77	12.92	4.84
Qadev Karam Village	1431378	22/08/2019	23/09/2019	774.58	1.08	1.00	15.69	5.88
MP8	1431380	23/08/2019	23/09/2019	746.00	1.02	0.94	15.37	5.76
Field Blank	1431382				0.08			
Laboratory Blank					0.03			

Comment: Results are blank subtracted

Overall M.U. ±9.6%

Reporting Limit 0.09µg SO_4^{2-}

Analysed on Dionex ICS1100 ICU11

Analyst Name Sam Minns

Report Checked By Andrew Poole

Date of Analysis 25/10/2019

Date of Report 29/10/2019

Analysis has been carried out in accordance with in-house method GLM1

REPORT OFFICIALLY CHECKED

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2187

LABORATORY ANALYSIS REPORT

DETERMINATION OF OZONE IN DIFFUSION TUBES BY ION CHROMATOGRAPHY

REPORT NUMBER N07595R

BOOKING IN REFERENCE No N07595

DESPATCH NOTE No 73775

CUSTOMER RSK Environment Llc (UAE) Attn: Andreea Stroe
PO Box 46112
Al Ghaith Tower, Suite 1202
Hamdan Bin Mohamed St.
Abu Dhabi

United Arab Emirates

DATE SAMPLES RECEIVED 10/10/2019

JOB NUMBER

Location	Sample Number	Date Exposed*	Date Finished*	Exposure Hours*	NO_3^- µg/ml	µg/ml NO_3^- - Blank	O_3 µg/m^3*	O_3 ppb*
Kormar Gamara Village	1431389	22/08/2019	23/09/2019	764.67	0.92	0.90	68.10	34.05
Kormar Bichuck Village	1431384	20/08/2019	23/09/2019	815.50	1.43	1.41	99.90	49.95
Taza Shahaw Village	1431385	20/08/2019	23/09/2019	814.83	1.68	1.67	118.27	59.13
Aweya Jalal Village	1431387	21/08/2019	23/09/2019	790.33	1.47	1.46	106.61	53.31
Shikh Hameed Village	1431386	21/08/2019	23/09/2019	792.75	1.11	1.09	79.55	39.77
Mamsik Village	1431391	24/08/2019	23/09/2019	726.33	1.59	1.58	125.42	62.71
Qadev Karam Village	1431388	22/08/2019	23/09/2019	774.58	1.16	1.15	85.54	42.77
MP8	1431390	23/08/2019	23/09/2019	746.00	1.55	1.54	119.23	59.62
Field Blank	1431392				0.02			
Laboratory Blank					0.01			

Comment: Results are blank subtracted

Overall M.U. ±10.2% **Reporting Limit** 0.049µg/ml NO_3^-

Analysed on Dionex ICS1100 ICU10

Analyst Name Sam Minns **Report Checked By** Andrew Poole

Date of Analysis 25/10/2019 **Date of Report** 29/10/2019

Analysis has been carried out in accordance with in-house method GLM 2

REPORT OFFICIALLY CHECKED

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Signed..
L. Gates, Laboratory Manager

LAND USE

During the land use survey, the following features were identified:

Table A2.3 Summary of land use features

Feature	Locations	Considerations
Residential buildings	Ali Mustafa, Khor Mor Gawra, Shekh Hameed	Dust, noise, vibration from passing vehicles, maintaining full access, community road safety.
Agricultural buildings	Ali Mustafa, Khor Mor Gawra	Dust, noise, vibration from passing vehicles, maintaining full access, community road safety, animal welfare.
Commercial buildings	One location identified along route (see coordinates in subsequent table)	Dust, noise, vibration from passing vehicles, maintaining full access, community road safety.
Land use types	Along entire transportation routes	Maintaining full access, presence of grazing animals, occasional road crossings by animals, dust, noise, vibration from passing vehicles, community road safety.
Public buildings - schools	Khor Mor Gawra, Shekh Hameed	Proximity to road side, community road safety.
Infrastructure	Mamisik, Qadir Karim, Shekh Hameed	Protection of local infrastructure.
Places of worship	Awaye Jalal, Shekh Hameed	Timing of religious celebrations and ceremonies.
Graveyards	Four locations identified along the route (see coordinates in subsequent table)	Maintaining full access, awareness of funeral processions.
Water points	Various locations (including Mamisik, Taza Shar, Shekh Hameed)	Seasonal use by livestock rearers, pollution.
Security features	Junction of Qadir Karim and Kirkuk roads	Security terms and conditions.

These features are further elaborated upon in the following table:

Table A2.4 Details of land use features

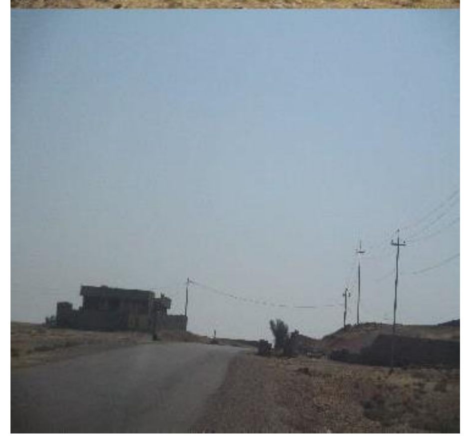
Coordinates	Feature	Location / Considerations	Photograph
35.125149 44.787287	Public building - school	Khor Mor Gawra Primary School **Considerations:** Community road safety, traffic management and school schedule awareness.	
35.078286 44.854561	Public building - school	Shekh Hameed Primary School **Considerations:** Community road safety, traffic management and school schedule awareness.	
35.108735 44.820016	Place of worship - mosque	Awaye Jalal **Considerations:** Place of local significance and worship. Schedule of local religious activities to manage traffic and access.	

35.07888 44.854116	Place of worship - mosque	Shekh Hameed **Considerations:** Place of local significance and worship. Schedule of local religious activities to manage traffic and access.	
35.21463 44.780444	Residential buildings - cluster of houses	Access to one house is approximately 100 metres from the road side **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety.	

35.20112 44.790301	Residential buildings - cluster of houses	Ali Mustafa **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety.	 

35.20112 44.790301	Residential buildings, other - cluster of houses, access road	Ali Mustafa and access road to Bariula **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, deterioration of road conditions, overhead power lines crossing the road.	 
35.199504 44.793867	Residential buildings, agricultural buildings - cluster of houses and animal shelter	Ali Mustafa **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community and road safety, animal welfare.	

35.131106 44.861126	Residential buildings – abandoned houses	Abandoned properties on either side of the road on route to Mamisik	

35.080837 44.852539	Residential buildings – housing units	Shekh Hameed **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, deterioration of road conditions, overhead power lines crossing the road.	 
35.202144 44.811118	Other – access road to residential building	**Considerations:** Maintaining full access.	

35.213547 44.850751	Residential buildings, graveyards – house under construction, graveyard	**Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, awareness of funeral processions.	 
35.214946 44.856572	Residential buildings - cluster of houses	Aliawa **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety.	

35.212057 44.875358	Residential buildings – housing units	**Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community and road safety, deterioration of road conditions.	 

35.205744 44.879739	Residential buildings - housing units	Houses located on both sides of road. **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community and road safety, deterioration of road conditions.	
35.204555 44.879489	Residential buildings, graveyards – housing unit, graveyard	Old property and graveyard **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, deterioration of road conditions, awareness of funeral processions.	
35.198026 44.876224	Residential building – housing unit	House located on side of road **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, deterioration of road conditions.	

35.125034 44.789886	Residential buildings – cluster of houses	Khor Mor Gawra **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, deterioration of road conditions.	
35.114111 44.810818	Other – abandoned structures	Shekh Hameed	

35.110507 44.816425	Residential buildings – housing units	Awaye Jalal **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community and road safety, deterioration of road conditions, overhead electricity lines.	
35.091496 44.842766	Residential buildings – housing units	Taza Shar **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community and road safety, deterioration of road conditions, overhead electricity lines.	

35.212755 44.828577	Agricultural buildings, water point – animal shelters, water point	Animal shelter located near to dry water path **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, animal welfare, pollution.	
35.176166 44.856105	Agricultural buildings – animal shelters	Animals shelter for goats, sheep and ducks **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, animal welfare.	
35.124447 44.792151	Agricultural buildings – animal shelters	Khor Mor Gawra **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, animal welfare.	

35.10837 44.820715	Agricultural buildings – animal shelters	Close to Taza Shar **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, animal welfare.	
35.157516 44.830778	Commercial buildings – collection of small shops	**Considerations:** Dust, noise, vibration from passing vehicles, maintaining full access, community road safety.	

35.203436 44.879185	Agricultural buildings – animal shelters	**Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, animal welfare.	

35.156096 44.832457	Land use – grazing land	Grazing land on route to Mamisik **Considerations:** Presence of grazing animals, occasional road crossings by animals.	 

35.212282 44.783494	Land use – grazing land	Grazing land on either sides of the road **Considerations:** Presence of grazing animals, occasional road crossings by animals.	

35.117486 44.806755	Land use – agricultural land	Land used for wheat farming on route to Shekh Hameed **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety.	

35.075073 44.857162	Land use – agricultural land	Land used for wheat farming on route to Shekh Hameed **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety.	 

35.206295 44.788023	Land use – grazing land	Grazing land on either sides of the road **Considerations:** Presence of grazing animals, occasional road crossings by animals.	

35.14863 44.844631	Land use – agricultural land	Land used for wheat farming **Considerations:** Maintaining full access.	 

35.148732 44.845396	Land use, water point – agricultural land, dry water path	Land used for wheat farming and dry water path on route to Mamisik **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, pollution.	 

35.143204 44.854907	Land use – grazing land	**Considerations:** Presence of grazing animals, occasional road crossings by animals.	 
35.141508 44.857615	Land use – agricultural land	Land used for wheat farming **Considerations:** Maintaining full access.	

35.12771 44.859544	Land use – agricultural land	Land used for wheat farming on route to Mamisik **Considerations:** Maintaining full access.	
35.117857 44.865078	Land use – agricultural land	Land used for wheat farming on route to Mamisik **Considerations:** Maintaining full access.	
35.104041 44.827317	Land use – agricultural land	Land used for wheat farming **Considerations:** Maintaining full access.	

35.097517 44.835701	Land use – agricultural land	Land used for wheat farming **Considerations:** Maintaining full access.	 

35.20112 44.790301	Graveyard	Graveyard located opposite Ali Mustafa **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, deterioration in road conditions, awareness of funeral processions.	
35.124582 44.791646	Graveyard	**Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, deterioration in road conditions, awareness of funeral processions.	

35.083803 44.850719	Graveyard	Graveyard on route to Shekh Hameed **Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, deterioration in road conditions, awareness of funeral processions.	
35.210752 44.784875	Other - access road to agricultural land	**Considerations:** Maintaining full access.	

35.086511 44.847453	Land use – agricultural land	**Considerations:** Maintaining full access.	 

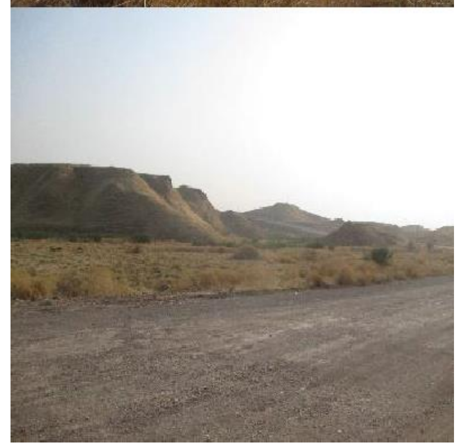
35.201549 44.804078	Land use, place of worship – grazing land and mosque	**Considerations:** Presence of grazing animals, occasional road crossings by animals. Place of local significance and worship, schedule of local religious activities to manage traffic and access.	 

44.817747 433.84024	Land use – grazing land	**Considerations:** Presence of grazing animals, occasional road crossings by animals.	 

35.212061 44.841182	Land use – grazing land (and access road to grazing land)	**Considerations:** Presence of grazing animals, occasional road crossings by animals, maintaining access.	 

35.193643 44.872109	Land use – agricultural and grazing land	**Considerations:** Maintaining full access, dust, noise, vibration from passing vehicles, community road safety, animal welfare.	 

35.166975 44.842947	Land use – grazing land	**Considerations:** Presence of grazing animals, occasional road crossings by animals.	 

35.158012 44.826355	Land use – grazing land	**Considerations:** Presence of grazing animals, occasional road crossings by animals.	
35.132835 44.820536	Land use – grazing land	**Considerations:** Presence of grazing animals, occasional road crossings by animals.	

35.123721 44.794543	Land use – grazing land	**Considerations:** Presence of grazing animals, occasional road crossings by animals.	 
35.13687 44.861373	Water source, infrastructure – dry water path and bridge	On route to Mamisik **Considerations:** seasonal water use by livestock rearers, protection of local infrastructure.	

35.092737 44.841349	Water source – dry water path	On route to Taza Shar **Considerations:** seasonal water use by livestock rearers.	

35.087597 44.724987	Water point, land use – dry water path, grazing land	**Considerations:** seasonal water use by livestock rearers, presence of grazing animals. occasional road crossings by animals.	

35.155575 44.833112	Water point – dry water path	On route to Mamisik **Considerations:** seasonal water use by livestock rearers.	
35.084317 44.7117	Land use – grazing land	**Considerations:** Presence of grazing animals, occasional road crossings by animals.	

35.125689 44.813932	Land use, other – grazing land, access road	**Considerations:** Presence of grazing animals, occasional road crossings by animals, maintaining access, deterioration of road conditions.	

35.1229 44.783429	Land use – agricultural land	**Considerations:** Maintaining full access.	

35.213117 44.831321	Water source, infrastructure – dry water path and bridge	**Considerations:** seasonal water use by livestock rearers, protection of local infrastructure.	 

35.214463 44.854687	Water source, infrastructure – dry water path and bridge	**Considerations:** seasonal water use by livestock rearers, protection of local infrastructure.	 

35.174043 44.852911	Water source – dry water path	**Considerations:** seasonal water use by livestock rearers.	 

35.163321 44.837084	Water source – dry water path	**Considerations:** seasonal water use by livestock rearers.	
35.124356 44.785665	Water source – dry water path	**Considerations:** seasonal water use by livestock rearers.	

35.214993 44.779476	Security feature – military checkpoint	Junction of Qadir Karim and Kirkuk roads **Considerations:** security terms and conditions, traffic and congestion.	
35.207747 44.880145	Security feature, other – military checkpoint, access road	Checkpoint and access road to Qadir Karim **Considerations:** security terms and conditions, traffic and congestion.	

35.105456 44.82487	Security feature, water point - military checkpoint, water path	**Considerations:** security terms and conditions, traffic and congestion.	

35.200722 44.878919	Security feature – military checkpoint	Qadir Karim **Considerations:** security terms and conditions, traffic and congestion.	

35.203436 44.879185	Water point, infrastructure – river, bridge	River crossing on route to existing facility at Qadir Karim **Considerations:** seasonal use by livestock rearers, protection of local infrastructure.	
35.150811 44.836649	Infrastructure - bridge	On route to Mamisik **Considerations:** protection of local infrastructure	

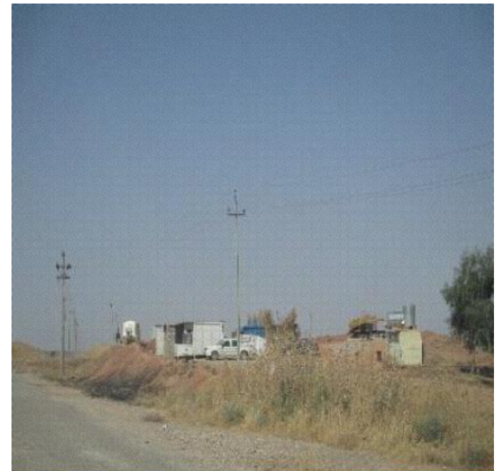
35.150045 44.838452	Infrastructure, land use - bridge, grazing land	On route to Mamisik **Considerations:** protection of local infrastructure, presence of grazing animals, occasional road crossings by animals.	 

35.095857 44.837719	Infrastructure, water point – bridge, dry water path	On route to Shekh Hameed **Considerations:** protection of local infrastructure, seasonal use by livestock rearers	
35.191113 44.871295	Water point, land use river, grazing land	**Considerations:** Presence of grazing animals, occasional road crossings by animals, seasonal use by livestock rearers, pollution.	

35.181023 44.864196	Security feature - police camp (OFPF)	**Considerations:** security terms and conditions.	
35.172402 44.850395	Security feature - police base (OFPF)	**Considerations:** security terms and conditions.	

35.15272 44.821091	Security feature - former checkpoint	**Considerations:** security terms and conditions.	

35.125156 44.811679	Security feature – security tower	**Considerations:** security terms and conditions.	 

35.122324 44.800199	Security feature - military base	**Considerations:** security terms and conditions.	

35.120763 44.802169	Security feature - military base	On route to Shekh Hameed **Considerations:** security terms and conditions.	
35.12338 44.861878	Security feature - military camp	On route to Mamisik **Considerations:** security terms and conditions.	

35.09226 44.766788	Security feature - military base	**Considerations:** security terms and conditions.	
35.088912 44.755051	Land use – grazing land	**Considerations:** Presence of grazing animals, occasional road crossings by animals.	

35.121915 44.800313	Other – former concrete patch plant	Khor Mor Bichuk	

RSK

TRAFFIC

Figure A2.1 Percentage of vehicle types (location one)

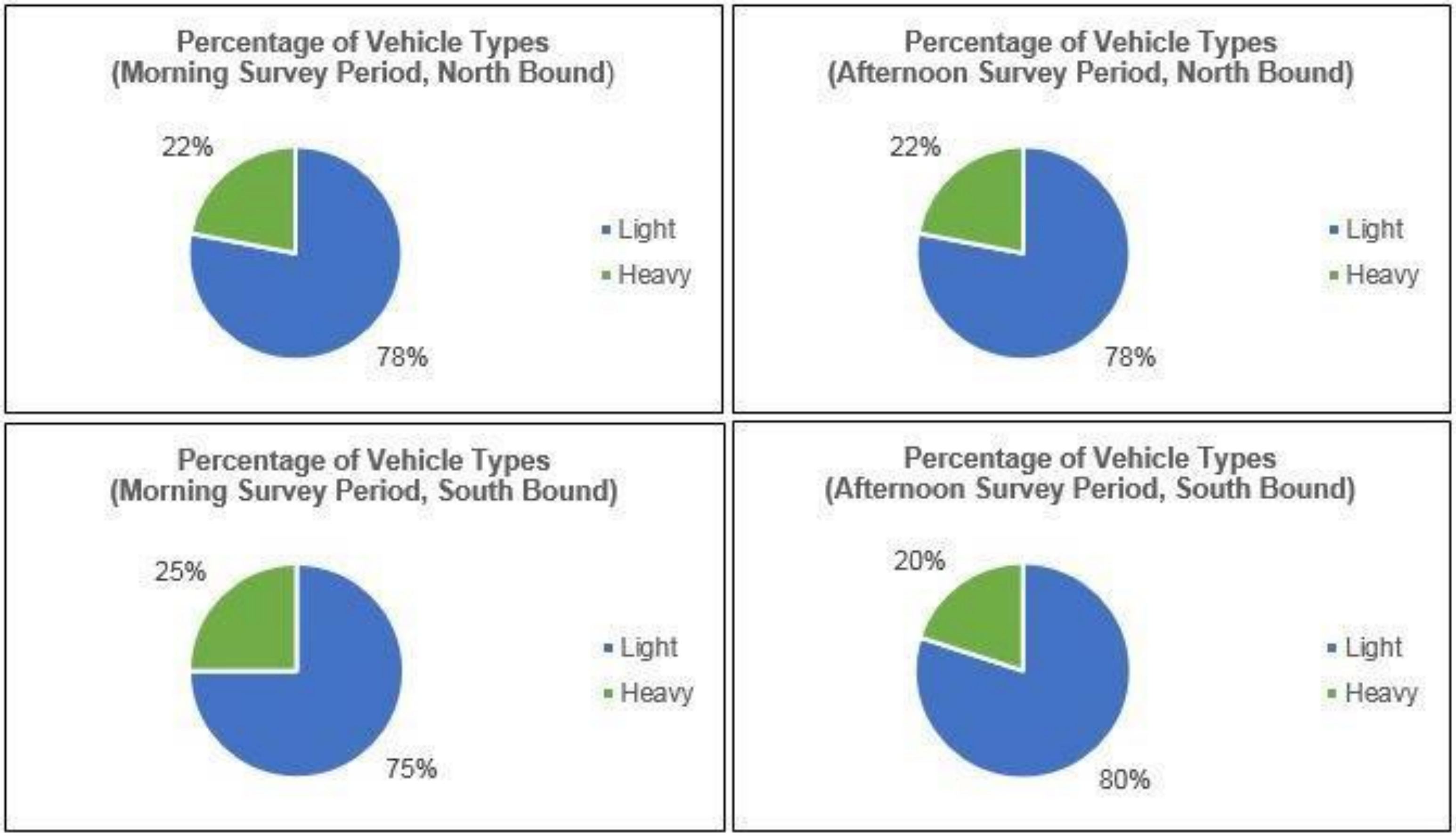


Figure A2.2 Percentage of vehicle types (location two)

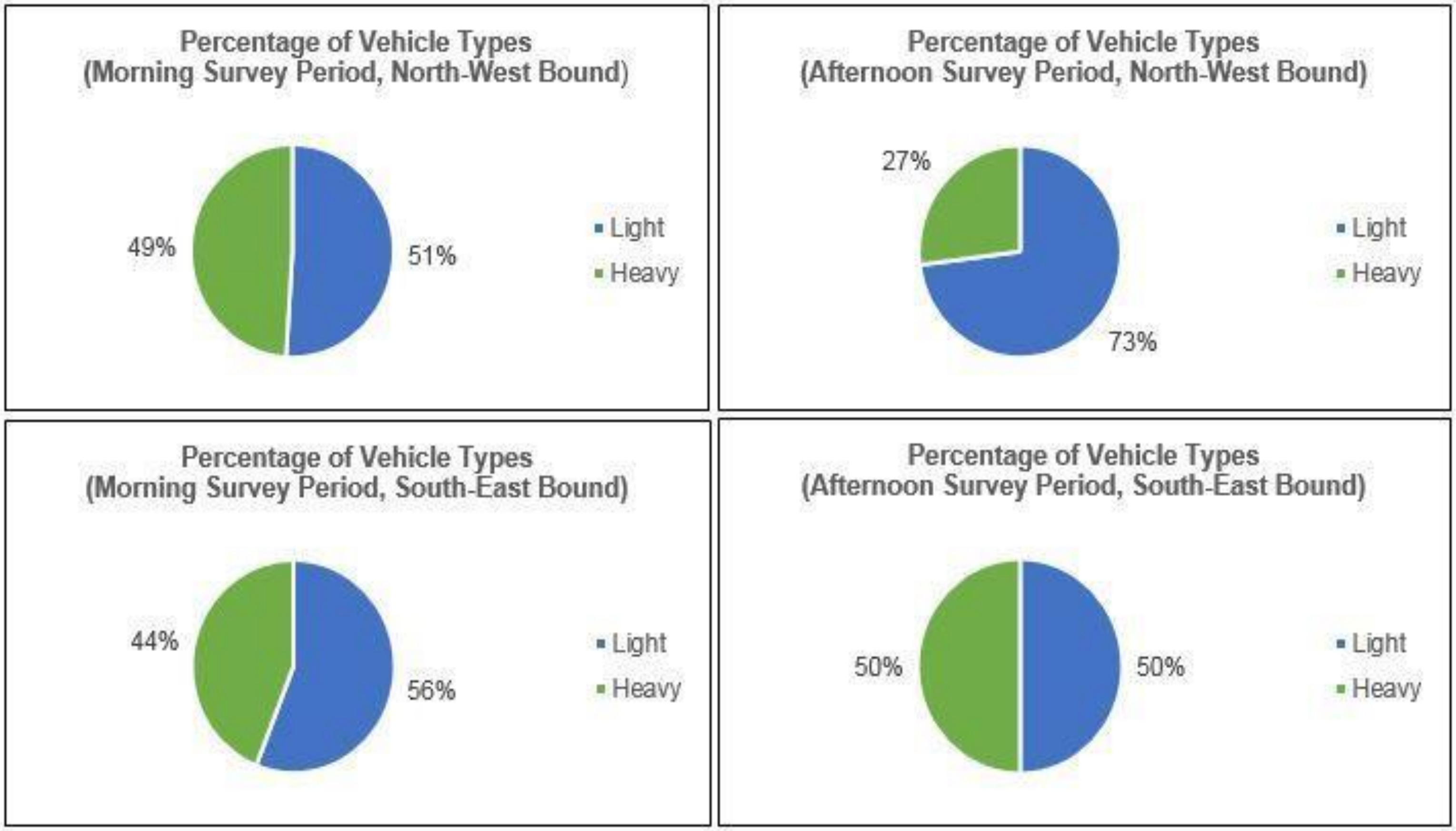


Figure A2.3 Percentage of vehicle types (location three)

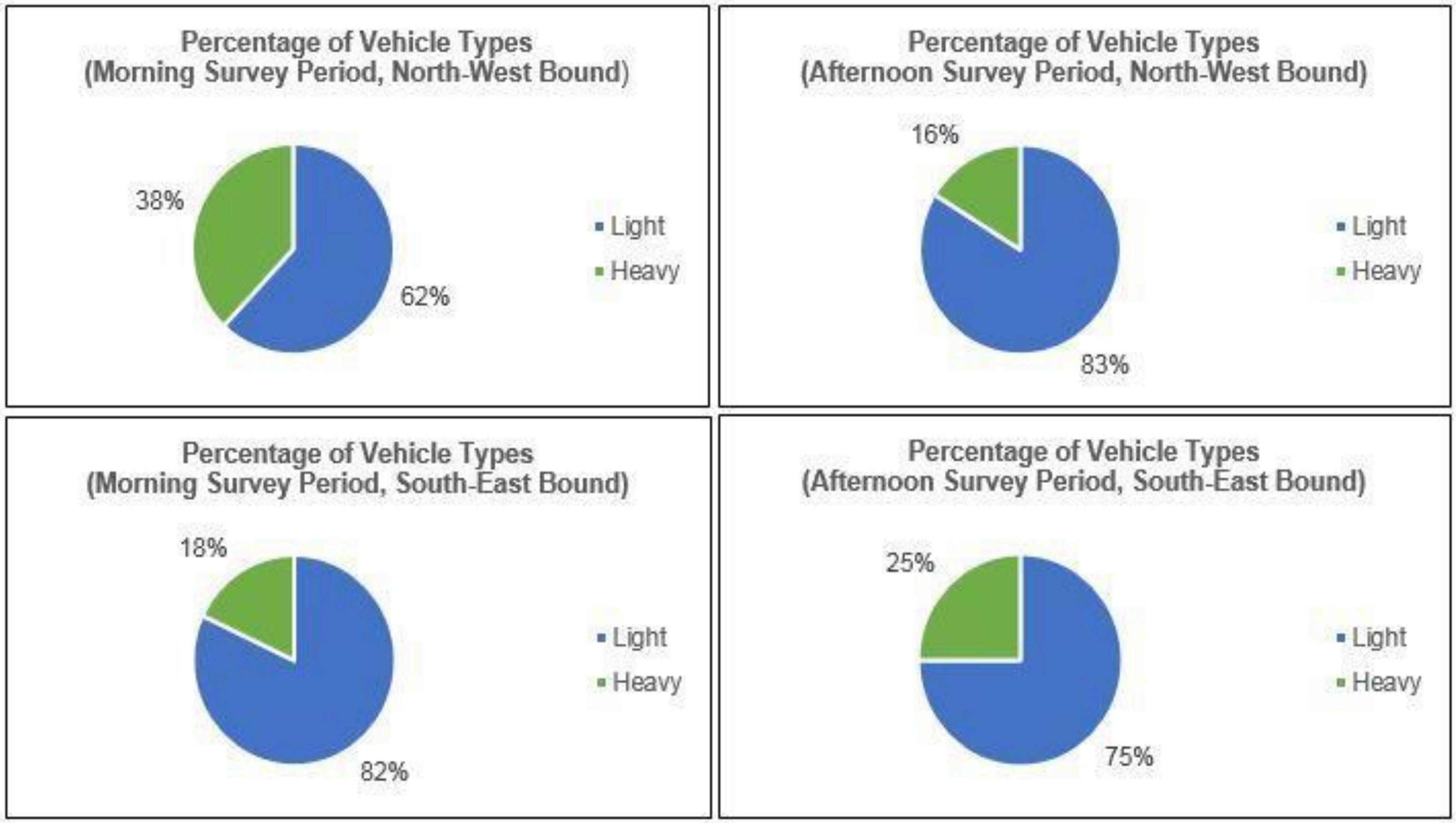


Figure A2.4 Percentage of vehicle types (location four)

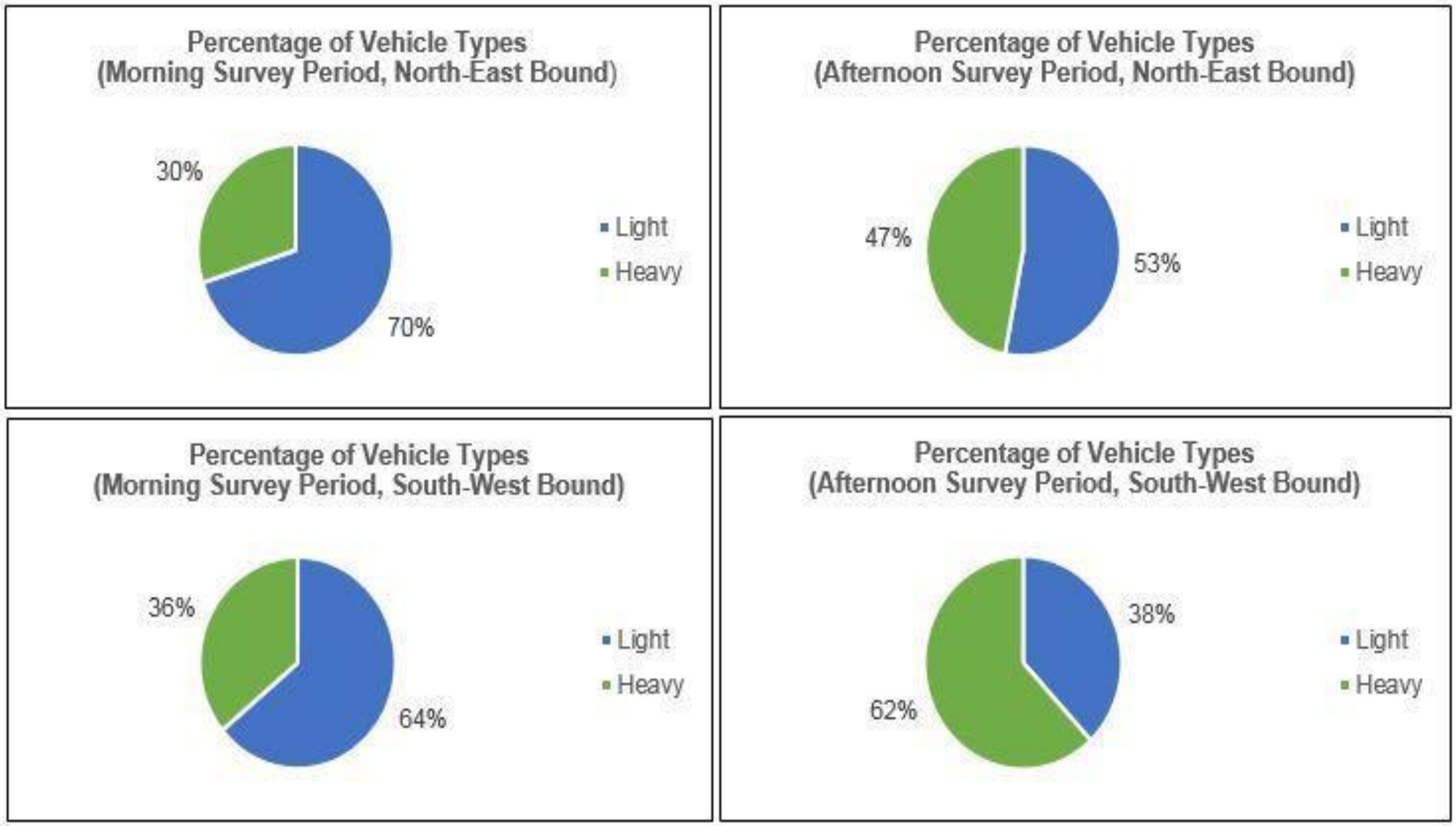


Figure A2.5 Percentage of vehicle types (location five)

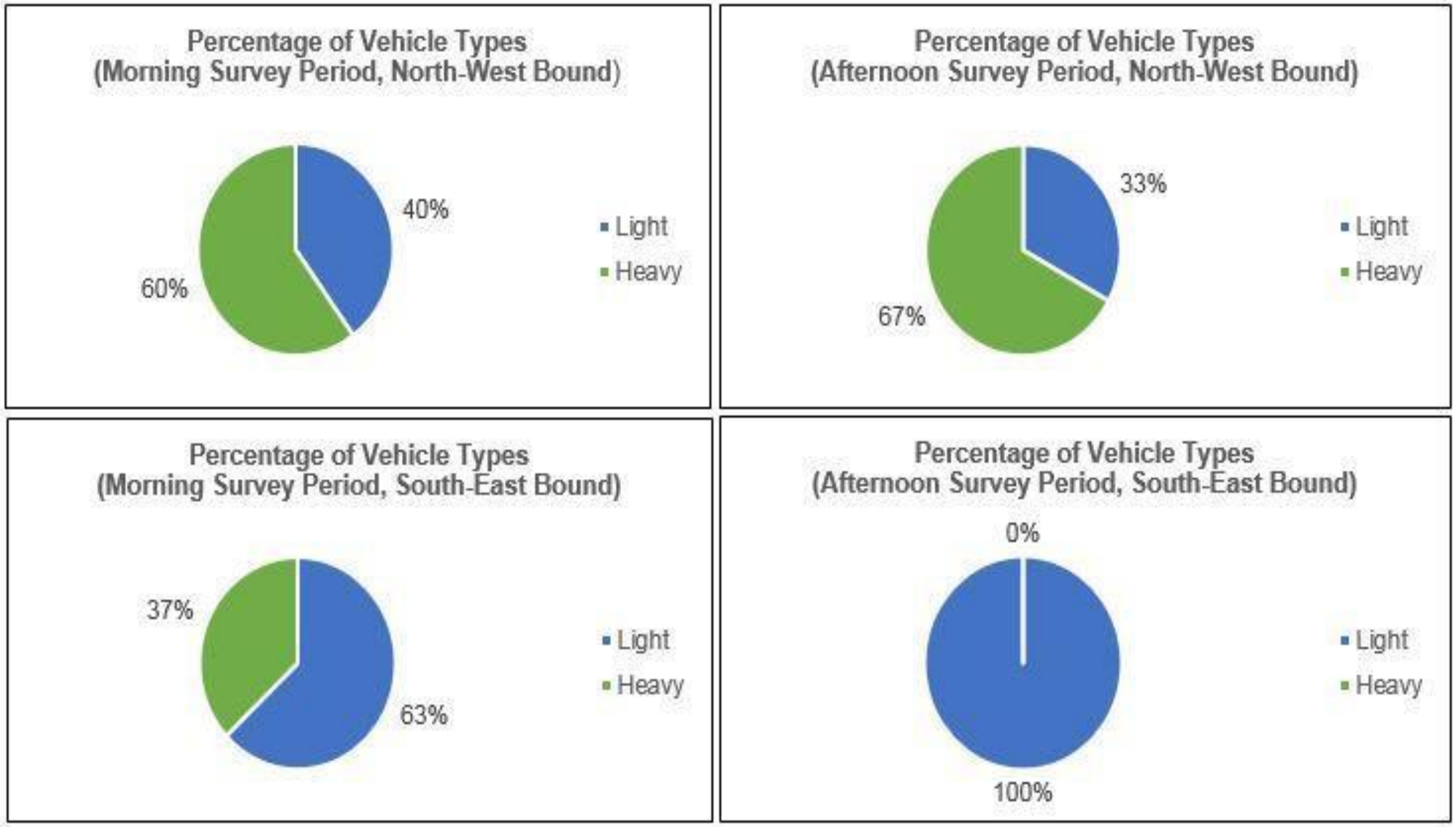
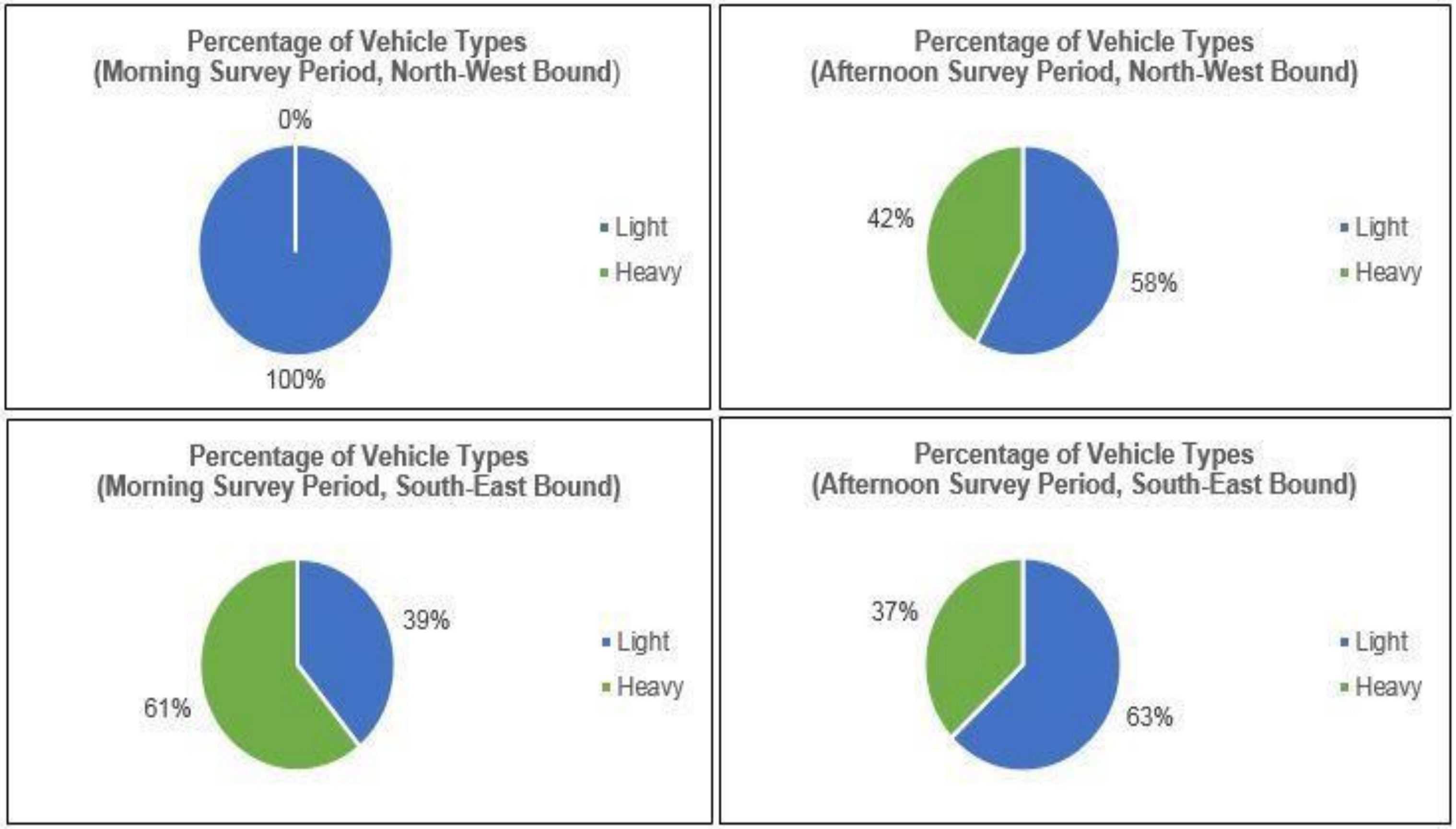


Figure A2.6 Percentage of vehicle types (location six)



ARCHAEOLOGY

ARCHAEOLOGICAL SITE FORM

1. Site Modern Name (local name): Sarcham Tepe

2. Site Ancient Name: ___________

3. Governorate: Sulaymaniyah

4. District: Chemchemal **Sub-district:** Qadir Karim

5. GPS Coordinates: 44.839762, 35.126667

6. Location Description:

Sarcham Tepe is located near the archaeology investigation site of the flowline (i.e. FL-Arch.7). The site's area is a hill with rectangle shape, its dimensions are 20x30 metres. The height to the site is approximately five metres higher than the surrounding flat area. The nearest PAC is Khor Mor Gawra, which is located to the north-west of this site. There is an unpaved road connecting to the site. There are wheat and barley farms nearby. There are signs of grazing in the area around the site. The site (the hill) is not protected by fence or security guards.

Historic Temporal Period(s):

☐ Sumerian (Early Dynastic), Akkadian and New Sumerian periods (3rd Dynastic of Ur) 3000-2000 BC

☐ Old Babylonian period (including Isin-Larsa period) 2025-1595 BC

☐ Medium Babylonian period (Kassite Dynastic) 1595 -1162 BC

☐ New Babylonian Period (including Land sea Dynastic, Chaldean Dynastic) 1124-539 BC

☐ Achaemenid period 539-331 BC

☐ Seleucid period 331-126 BC

☐ Parthian period 126 BC-227 AD

☐Sassanid period 226-637 AD

☐ Islamic periods 637-1258 AD

☐ Ottoman period 1500-1918 AD

Has the site been excavated? ☐ Yes ☐ No

Has the site been looted? ☐ Yes ☐ No

Is the site threatened? ☐ Yes ☐ No

Figure A2.7 Sarcham Tepe viewpoint one

Figure A2.8 Sarcham Tepe viewpoint two

Figure A2.9 Sarcham Tepe viewpoint three

ARCHAEOLOGY

ARCHAEOLOGICAL SITE FORM

1. Site Modern Name (local name): Graves tapa Julaka

1. Site Ancient Name:

3. Governorate: Sulaymanyh

District: Qormor bchuk Sub-district: Qadir Karam

GPS Coordinates باحداثيات نظام تحديد الموقع
44.814135
35.127112

6. Location Description وصف الموقع:
Site rectangle shape, dimensions are 150x100 meters. The height to the site of 100 cm meters. The nearest village is qormor bchuk village which is located to the west of this site. There is paved road connecting to the site. The site is not protected by fence or security guards.

Historic Temporal Period(s): الخيارات تختر واحدة من

- ☐ **Sumerian(Early Dynastic), Akkadian and New Sumerian periods (3rd Dynastic of Ur) 3000-2000 B.C**
- ☐ **Old Babylonian period (including Isin-Larsa period) 2025-1595 BC**
- ☐ **Medium Babylonian period (Kassite Dynastic) 1595 -1162 BC**
- ☐ **New Babylonian Period (including Land sea Dynastic, Chaldean Dynastic) 1124-539 BC**
- ☐ **Achaemenid period 539-331 BC**
- ☐ **Seleucid period 331-126 BC**
- ☐ **Parthian period 126 BC-227 AD**
- ☐ **Sassanid period 226-637 AD**
- ■ **Ottoman period 1500-1918 A.D.**

Has the site been excavated? ☐ Yes ■ No

Has the site been looted?( ) Yes ■ No

Is the site threatened?( ) Yes ■ No

Note: Due to the COVID-19 situation at the time of report preparation, the archaeological record was taken from a screen shot and the archaeologist could not access the original file

APPENDIX 3
PROJECT STANDARDS

Soil standards

Table A3.1: Summary of soil quality standards (mg/kg)

Metals	Australian ecological investigation levels	Australian health investigation levels				Dutch intervention value	Selected Project standard
		A	B	C	D		
Arsenic (total)	20	100	400	200	500	-	**20**
Beryllium	-	20	80	40	100	-	**20**
Cadmium	3	20	80	40	100	-	**3**
Chromium (III)	400	12%	48%	24%	60%	-	**400/12%**
Chromium (VI)	1	100	400	200	500	-	**1**
Cobalt	50	100	400	200	500	-	**50**
Copper	100	1000	4000	2000	5000	-	**100**
Lead	600	300	1200	600	1500	530	**300**
Manganese	500	1500	6000	3000	7500	-	**500**
Methyl Mercury	-	10	40	20	50	-	**10**
Mercury (inorganic)	1	15	60	30	75	-	**1**
Nickel	60	600	2400	600	3000	-	**60**
Zinc	200	7000	28000	14000	35000	720	**200**
Organics							
Aldrin + Dieldrin	-	10	40	20	50	-	**10**
Chlordane	0.5	50	200	100	250	-	**0.5**
DDT+DDD+DDE	1	200	800	400	1000	-	**1**
Heptachlor	0.5	10	40	20	50	-	**0.5**
Polycyclic aromatic Hydrocarbons (PAHs)	-	20	80	40	100	-	**20**
Benzo(a)pyrene	1	1	4	2	5	-	**1**
Phenol	-	8500	34000	17000	42500	-	**8500**
PCBs (Total)	1	10	40	20	50	-	**1**
Petroleum Hydrocarbon Components (constituents): >C16 – C35 Aromatics	-	90	360	180	450	5000 for C10-C40 (mineral oil)	**90**
>C16-C35 Aliphatics	-	5600	22400	11200	28000	-	**5600**
>C35 Aliphatics	-	56000	224000	112000	280000	-	**56000**

Metals	Australian ecological investigation levels	Australian health investigation levels				Dutch intervention value	Selected Project standard
		A	B	C	D		
Other							
Boron	-	3000	12000	6000	15000	-	**3000**
Cyanides (Complexed)	50	500	2000	1000	2500	-	**50**
Cyanides (free)	10	250	1000	500	1250	-	**10**

Water standards

Table A3.2: Summary of Iraqi water quality standards and wastewater discharge standards

Parameters	Limits for receiving water body (mg/L)				Discharge limits (mg/L)		Selected Project standard
	A-1: Rivers and their tributaries and branches	A-2: Streams, brooks and canals and their original and secondary branches	A-3: Lakes, basins and others of water compounds	A-4: Springs, wells and groundwater	B-1: Remaining waters discharged to the water source	B-2: Remaining waters discharged to the public sewages	
Colour	Normal	Normal	Normal	Normal	-	-	**Normal**
Temperature	-	-	-	-	35°C	45°C	**-**
Suspended Materials	-	-	-	-	60	750	
Hydrogen Ion Concentration (pH)	6.5 to 8.5	8.5	8.5		6 to 9.5	6 to 9.5	**6.5 to 8.5**
Dissolved Oxygen	More than 5	More than 5	More than 5		-	-	**More than 5**
BOD_5	5	5	3		40	1,000	**5**
COD ($Cr_2 O_7$ method)	-	-	-	-	100	-	**-**
Cyanide	0.02	0.02	0.02	0.02	0.05	0.5	**0.02**
Fluorine	0.2 or more according to what exist naturally in the source				5.0	10	**0.2**
Free Chlorine	Trace	Trace	Trace	Trace	Trace	100	**Trace**

<table>
<tr><th rowspan="2">Parameters</th><th colspan="4">Limits for receiving water body
(mg/L)</th><th colspan="2">Discharge limits
(mg/L)</th><th rowspan="2">Selected Project standard</th></tr>
<tr><th>A-1:
Rivers and their tributaries and branches</th><th>A-2:
Streams, brooks and canals and their original and secondary branches</th><th>A-3:
Lakes, basins and others of water compounds</th><th>A-4:
Springs, wells and groundwater</th><th>B-1:
Remaining waters discharged to the water source</th><th>B-2:
Remaining waters discharged to the public sewages</th></tr>
<tr><td rowspan="2">Chlorides</td><td>200</td><td>200</td><td>200</td><td>200</td><td colspan="2" rowspan="2">If the ratio of the quantity of waters discharged to the quantity of the water source is 1:1,000 or less, then it is allowed to increase the concentration in the source by 1% of the normal concentration in the source before discharging.
If the ratio of the quantity of the discharged waters to the quantity of the sources waters is more than 1:1,000, then the concentration of chlorides in the discharged waters must not exceed 600 mg/L.
If the concentration of fluorides in the source waters is less than 200 mg/L, then each case is considered separately by the side responsible for applying the regulation.</td><td rowspan="2">200</td></tr>
<tr><td colspan="4">Or more according to what is normal in the source.</td></tr>
<tr><td>Phenol</td><td>0.005</td><td>0.005</td><td>0.005</td><td>0.005</td><td>0.01- 0.05</td><td>5 - 10</td><td>0.005</td></tr>
<tr><td rowspan="2">Sulphates</td><td>200</td><td>200</td><td>200</td><td>200</td><td colspan="2" rowspan="2">If the ratio of the quantity of the discharged waters to the quantity of the source waters 1:1,000 or less, then it is allowed to discharge waters to the source in concentration and quantities leading to the increase in the concentration of sulphates in the source by 1% of the normal concentration in the source before discharge.
If the ratio of the quantity of the discharged</td><td rowspan="2">200</td></tr>
<tr><td colspan="4">Or more according to what is normal to the source.</td></tr>
</table>

Parameters	Limits for receiving water body (mg/L)				Discharge limits (mg/L)		Selected Project standard
	A-1: Rivers and their tributaries and branches	A-2: Streams, brooks and canals and their original and secondary branches	A-3: Lakes, basins and others of water compounds	A-4: Springs, wells and groundwater	B-1: Remaining waters discharged to the water source	B-2: Remaining waters discharged to the public sewages	
					waters to the quantity of the source waters is more than 1:1,000, then the concentration of sulphates in the discharged waters must not exceed 400 mg/L. If the concentration of sulphates in the source waters is less than 200 mg/L, then each case is considered separately by the party responsible for applying the regulations.		
Nitrates	15	15	15	50	50	-	**15**
Phosphates	0.4	0.4	0.1	0.4	3	-	**0.04**
Ammonium	1	1	1	-	-	-	**1**
DDT insecticides	0	0	0	0	0	-	**0**
Lead	0.05	0.05	0.05	0.05	0.1	0.1	**0.05**
Arsenic	0.05	0.05	0.05	0.05	0.05	0.05	**0.05**
Copper	0.05	0.05	0.05	0.01	0.2	-	**0.05**
Nickel	0.1	0.1	0.1	0.1	0.2	0.1	**0.1**
Selenium	0.1	0.1	0.1	0.1	0.05	-	**0.1**
Mercury	0.001	0.001	0.001	0.001	0.005	0.001	**0.001**
Cadmium	0.005	0.005	0.005	0.005	0.01	0.01	**0.005**
Zinc	0.5	0.5	0.5	0.1	2	0.1	**0.5**

<table>
<tr><th rowspan="2">Parameters</th><th colspan="4">Limits for receiving water body
(mg/L)</th><th colspan="2">Discharge limits
(mg/L)</th><th rowspan="2">Selected Project standard</th></tr>
<tr><th>A-1: Rivers and their tributaries and branches</th><th>A-2: Streams, brooks and canals and their original and secondary branches</th><th>A-3: Lakes, basins and others of water compounds</th><th>A-4: Springs, wells and groundwater</th><th>B-1: Remaining waters discharged to the water source</th><th>B-2: Remaining waters discharged to the public sewages</th></tr>
<tr><td>Chromium</td><td>0.05</td><td>0.05</td><td>0.05</td><td>0.05</td><td>0.1</td><td>0.1</td><td>0.05</td></tr>
<tr><td>Aluminium</td><td>0.1</td><td>0.1</td><td>0.5</td><td>-</td><td>5</td><td>20</td><td>0.1</td></tr>
<tr><td>Barium</td><td>1</td><td>1</td><td>1</td><td>1</td><td>4</td><td>0.1</td><td>1</td></tr>
<tr><td>Boron</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Cobalt</td><td>0.05</td><td>0.05</td><td>0.05</td><td>0.05</td><td>0.5</td><td>0.5</td><td>0.05</td></tr>
<tr><td>Iron</td><td>0.3</td><td>0.3</td><td>0.3</td><td>0.5</td><td>2</td><td>15</td><td>0.3</td></tr>
<tr><td>Manganese</td><td>0.1</td><td>0.1</td><td>0.1</td><td>0.1</td><td>0.5</td><td>-</td><td>0.2</td></tr>
<tr><td>Silver</td><td>0.01</td><td>0.01</td><td>0.01</td><td>0.01</td><td>0.05</td><td>0.1</td><td>0.02</td></tr>
<tr><td>Total Hydrocarbons and their Derivatives</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2" rowspan="2">It is allowed to discharge the total of hydrocarbon materials to the water sources A-1 and A-2 according to the concentrations and limitations shown in the table, provided that these concentrations are measured before being mixed with the waters of the water source and it is not possible to discharge any hydrocarbon materials to the water sources A-3 and A-4.
First: 10 mg/L and according to the following limitations.
The ratio of the quantity of the discharged waters to the quantity of the water source is not less than 1:1,000.</td><td>-</td></tr>
<tr><td></td><td></td><td>Total hydrocarbons and their derivatives</td><td>-</td><td>-</td><td></td></tr>
</table>

<table>
<tr><th rowspan="2">Parameters</th><th colspan="4">Limits for receiving water body
(mg/L)</th><th colspan="2">Discharge limits
(mg/L)</th><th rowspan="2">Selected Project standard</th></tr>
<tr><th>A-1:
Rivers and their tributaries and branches</th><th>A-2:
Streams, brooks and canals and their original and secondary branches</th><th>A-3:
Lakes, basins and others of water compounds</th><th>A-4:
Springs, wells and groundwater</th><th>B-1:
Remaining waters discharged to the water source</th><th>B-2:
Remaining waters discharged to the public sewages</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2">The condition of the river should be in continuous flow.
Second: 5 mg/L according to the following limitations.
The ratio of the quantity of discharged waters to the quantity of the source waters is not less than 1: 500 or less.
The condition of the river should be in continuous flow.
Third: 3 mg/L and according to the following limitations.
The ratio of the quantity of discharged waters to the quantity of source waters is not less than 1: 300.
The condition of the river should be in continuous flow.</td><td></td></tr>
<tr><td>Sulphides</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>3</td><td>-</td></tr>
<tr><td>Ammonia</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>10</td><td>-</td></tr>
<tr><td>Ammonia gas</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>6</td><td>-</td></tr>
<tr><td>Sulphur Dioxide</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>7</td><td>-</td></tr>
<tr><td>Petroleum Alcohol</td><td>-</td><td>-</td><td>-</td><td>-</td><td></td><td>Not permitted</td><td>-</td></tr>
</table>

Parameters	Limits for receiving water body (mg/L)				Discharge limits (mg/L)		Selected Project standard
	A-1: Rivers and their tributaries and branches	**A-2: Streams, brooks and canals and their original and secondary branches**	**A-3: Lakes, basins and others of water compounds**	**A-4: Springs, wells and groundwater**	**B-1: Remaining waters discharged to the water source**	**B-2: Remaining waters discharged to the public sewages**	
Calcium Carbide	-	-	-	-	-	Not permitted	-
Organic Solvents	-	-	-	-	-	Not permitted	-
Benzene	-	-	-	-	-	0.5	-
Chlorobenzene	-	-	-	-	-	0.1	-
TNT	-	-	-	-	-	0.5	-
Bromine	-	-	-	-	-	1-3	-

Table A3.3: Drinking water standards (Iraqi Standard Specification number 417 of 2001)

Characteristic	Maximum allowable limit (mg/L)
Natural characteristics	
Colour	10 units
Turbidity (NTU)	5 units
Taste	Accepted
Smell	Accepted
pH value	6.5 – 8.5
Chemical characteristics	
Arsenic	0.01
Cadmium	0.003
Chrome	0.05
Cyanide	0.02
Fluoride	1.0
Lead	0.01
Mercury	0.001
Nitrate	50
Nitrite	3
Selenium	0.01
Aluminium	0.2
Chloride	250
Copper	1.0
Total hardness (as $CaCO_3$)	500
Iron	0.3
Manganese	0.1
Sodium	200
TDS	1,000
Sulphate	250
Zinc	3.0
Calcium	50
Magnesium	50
Barium	0.7
Nickel	0.02
Dissolved hydrocarbons	0.01
Carbon-chloroform extracted	0.3
Industrial detergents	0.3
Phenolic compounds	0.002

Characteristic	Maximum allowable limit (mg/L)
Biological characteristics	
Coliform (100 ml after 24hr at 35°C)	<1.1
E. Coli (100 ml after 24hr at 44°C)	<1.1
Escherichia coli (250 ml after 24hr at 35°C)	Zero
Plate count (1 ml after 24hr at 35°C)	Zero
Pesticides	
Organic chloro (chlorinated)	0.07
Organic phosphorus	0.000005
Multi chloro-diphenolic	0.001
Radiation	
Total Alfa radiation	0.1
Total Beta radiation	1

Noise standards

Table A3.4: Maximum noise level limits

Receptor	Time period	One Hour LAeq (dBA)			
		KRG	GoI	IFC	Selected Project standard
Residential	07:00 – 18:00	50-60	55	55	**50-60**
	18:00 – 22:00	45-55			**45-55**
	22:00 – 07:00	40-50	45	45	**40-50**
Commercial	07:00 – 18:00	55-65	70	70	**55-65**
	18:00 – 22:00	55-60			**55-60**
	22:00 – 07:00	45-55	70	70	**45-55**
Industrial	07:00 – 18:00	60-70	70	70	**60-70**
	18:00 – 22:00	55-65			**55-65**
	22:00 – 07:00	50-60	70	70	**50-60**

NOTE: IFC guideline values are for noise levels measured out of doors. Daytime and night time periods are defined as 07:00-22:00 and 22:00-07:00 respectively in the IFC guideline. The stricter time period comes from KRG legislation and shall therefore be adopted by the Project.

Table A3.5: Acceptable noise level limits for construction activities

Receptor	Time period	One Hour LAeq (dBA)			
		KRG	GoI	IFC	Selected Project standard
Residential	07:00 – 19:00	75	55	55	**55**
	19:00 – 07:00	60	45	45	**45**
Commercial	07:00 – 19:00	80	70	70	**70**
	19:00 – 07:00	65	70	70	**65**
Industrial	07:00 – 19:00	85	70	70	**70**
	19:00 – 07:00	70	70	70	**70**

NOTE: IFC guideline values are for noise levels measured out of doors· Daytime and night time periods are defined as 07:00-22:00 and 22:00-07:00 respectively in the IFC guideline. The stricter time period comes from KRG legislation and shall therefore be adopted by the Project.

Air quality standards

Table A3.6 Ambient air quality standards

Parameter	Averaging Period	Unit	KRG	GoI	WHO/IFC	Selected Project Standard
Sulphur dioxide (SO_2)	1 year	µg/m³	20 - 60	47 (0.018 ppm)		**20 - 47**
	24 hours	µg/m³	125 -150	105 (0.04 ppm)	20 (interim limit 125)	**20**[2,4]
	3 hours	µg/m³	350			**262**[3]
	1 hour	µg/m³		262 (0.1 ppm)		**262 (0.1ppm)**
	10 minutes	µg/m³			500	**500**
Carbon monoxide (CO)	8 hours	ppm	10	9-10		**9-10**
	1 hour	ppm	30	35		**30**
Nitrous dioxide (NO_2)	1 year	µg/m³	100	75 (0.04 ppm)	40	**40**[2]
	24 hours	µg/m³	150	94 (0.05 ppm)		**94**
	1 hour	µg/m³	200 -400		200	**200**
Suspended particles (such as black smoke)	1 year	µg/m³	60			**60**
	24 hours	µg/m³	100 -150			**100 - 150**
Total suspended particles	1 year	µg/m³	90	150		**90**
	24 hours	µg/m³	230	350		**230**
Particulate matter (PM10)	1 year	µg/m³	50		20	**20**[2]
	24 hours	µg/m³	150	150	50	**50**[2]

Parameter	Averaging Period	Unit	KRG	GoI	WHO/IFC	Selected Project Standard
Particulate matter (PM2.5)	1 year	μg/m³	15	15	10	**10**[2]
	24 hours	μg/m³	35	35	25	**25**[2]
Falling dust (residential zone)	30 days	t/km²/month		10		**10**
Falling dust (industrial zone)	30 days	t/km²/month		20		**20**
Hydrocarbons	3 hours	ppm		0.24		**0.24**
Benzene	1 year	mg/m³		0.003		**0.003**

1 Where necessary, the values as per the standard are specified with relevant units in brackets. Units were converted between ppm and μg/m³ at 25ºC and pressure of 1 atm.

2 Legislated standard is significantly less stringent than IFC. As outlined in the IFC's Performance Standard 3 (Resources Efficiency and Pollution Prevention), the EPC Contractor will need to evaluate whether the legislated standards are appropriate in view of specific project circumstances and provide justification for any proposed derogations through the Project's environmental and social risks and impacts identification and assessment process.

3 The GoI ambient air quality standard for SO_2 at an averaging period of 1 hour is stricter than the KRG's standard at an averaging period of 3 hours. It is standard practice for ambient air quality standards to be less strict at shorter averaging periods. Therefore, the GoI/ standard for SO_2 at an averaging period of 1 hour is set as the Project Standard for both 1 hour and 3 hours.

4 Air quality guideline value, as per IFC General Environmental Health and Safety Standards (2007) referencing WHO Ambient Air Quality Guidelines (125 μg/m³ is the interim limit).

Table A3.7 Maximum Allowable Emissions Limits of Air Pollutants Emitted from Stationary Sources

Parameter	Sources[2]	Maximum Allowable Emissions Limits (mg/Nm^3)[1]			
		KRG	GoI	IFC	Selected Project Standard
Visible emissions[3]	Combustion sources		250		**250**
Opacity	All sources		20%		**20%**
Carbon monoxide (CO)	All sources		500	100	**100[4]**
Nitrogen oxide (NOx)	All sources	Varies depending on Combustion Source		150	**150**
Sulphur dioxide (SO_2)	All sources		500	75	**75[4]**
Total suspended particles (TSP)	Combustion sources		250		250
Benzene	All sources		5		**5**
Mercury and its compound (Hg)	All sources		0.5		**0.5**
Hydrogen sulphide (H_2S)	All sources		5		**5**
Total volatile organic compounds (VOC)	All sources		20	100	**20**
Particulate matter (PM10)	All sources			10	**10**

1 All units are in milligram per normal cubic meters (mg/Nm^3) where normal cubic meters are measured at 25^{o}C and 1 atm.

2 Relevant combustion sources as defined by Law no. 27, 2009 include incinerators and boilers.

3 The limit of “visible emissions” does not apply to emissions of water vapour and a reasonable period for cold start-up, shutdown or emergency operation.

4 In this case, the legislated standard is significantly less stringent than those provided by the IFC. As outlined in the IFC’s Performance Standard 3 (Resources Efficiency and Pollution Prevention), the EPC Contractor will need to evaluate whether the legislated standards are appropriate in view of specific project circumstances and provide a full and detailed justification for any proposed derogations through the Project’s environmental and social risks and impacts identification and assessment process.

Table A3.8 Maximum allowable emissions limits of air pollutants emitted from hydrocarbon fuel combustion sources

Parameter	Combustion / Technology Fuel Type	Maximum Allowable Emissions Limits (mg/Nm^3)[1]		
		GoI	IFC[4]	Selected Project Standard
Visible emissions[3]	All	250		**250**
Carbon monoxide (CO)	All	500		**500**
Nitrogen oxide (NOx)	Engine - spark ignition gas fuels	350	183 (200)[2]	**183[8]**
	Engine - dual fuel gas fuels	350	366 (400)[2]	**350**
	Engine liquid fuels	500		**500**
	Turbine gas fuels	70	47 (25 ppm)[3,6]	**47[8]**
Sulfur dioxide (SO_2)	All	500		**500**
	Engine liquid fuels	500	Use of 1.5% or less Sulphur Fuel[9]	**500** Use of 1.5% or less Sulphur Fuel[9]
Total suspended particles (TSP)	All fuels	250		**250**
	Engine liquid fuels	250		**250**
Particulate matter	Engine LIquid fuels		45.8 (50)[2,7]	**45.8[7,8]**
Excess O_2 content (dry gas)	Engines and turbines all fuels		15%	**15%**

[1] All units are in milligram per normal cubic meters (mg/Nm^3) where normal cubic meters are measured at 25°C and 1 atm.

[2] The units used by the IFC are in Nm^3 at 1 atm, 0°C which are shown in brackets. This has been converted to ensure a consistent basis for Nm^3 at 25°C and 1 atm.

[3] The units used by the IFC are in ppm. Units were converted between ppm and mg/Nm^3 at 25°C and pressure of 1 atm.

[4] IFC guidelines only apply to small combustion facilities which operate more than 500 hours per year with an annual capacity utilisation factor of more than 30%.

[5] The NOx guidelines for liquid engines in the IFC vary with bore size diameter.

[6] This IFC guideline applies to natural gas turbines which have a heat input of 15 – 30 MW on a heat basis.

[7] This IFC guideline can be increased to 92 mg/Nm^3 if it can be justified by project specific considerations.

[8] In this case, the legislated standard is significantly less stringent than those provided by the IFC. As outlined in the IFC's Performance Standard 3 (Resources Efficiency and Pollution Prevention), the EPC Contractor will need to evaluate whether the legislated standards are appropriate in view of specific project circumstances and provide a full and detailed justification for any proposed derogations through the Project's environmental and social risks and impacts identification and assessment process.

[9] This IFC guideline can be increased to 3% if it can be justified by project specific considerations.

APPENDIX 4
KM250A PROJECT ESIA
BIODIVERSITY SURVEY RESULTS

Table A4.1 List of vascular plant species for baseline botanical survey (2019)

Scientific name	IUCN (2019) status	Habitat of occurrence	Countries of occurrence according to IUCN (2019)
Centaurea solstitialis	Not assessed	Grasslands, disturbed areas (i.e. roadsides, abandoned fields & waste land) and cropland.	Native to It is native to Armenia, Azerbaijan, Georgia, Iran, Iraq, Lebanon, Syria, Tajikistan, Turkey, Turkmenistan, Ukraine, Algeria, Tunisia, Albania, Bulgaria, France, Greece, Italy, Spain and former Yugoslavia. This species is classed as an exotic / invasive species in several counties including but not limited to Australia, Argentina, Chile & USA (CAB International, 2019).
Zoegea leptaurea	Not assessed		Saudi Arabia, Syria, Lebanon & Turkey
Anchusa italica	Not assessed		>39 countries including Iraq (NE-Iraq, NW-Iraq & SE-Iraq)
Onosma sericeum	Not assessed		Turkey, Iran, Iraq (NE-Iraq, NW-Iraq), Lebanon, Syria Armenia & Georgia
Capsella bursa-pastoris	Least Concern	Artificial / terrestrial, grassland	> 39 countries
Eruca vesicaria	Least Concern	Marine intertidal, artificial/terrestrial, wetlands (inland), rocky areas (e.g. inland cliffs, mountain peaks) & grassland	Bulgaria, Croatia, France, Greece, Italy, Malta, Moldova, Portugal, Romania, Spain, Turkey & Ukraine
Lomelosia leucactis (synonym *Scabiosa leucactis*)	Not assessed		Iraq (NW-Iraq)
Lomelosia calocephala (synonym *Scabiosa calocephala*)	Not assessed		Turkey, Iran (N-Iran), Iraq (NW-Iraq), Lebanon & Syria
Ankyropetalum gypsophiloides (synonym *Gypsophila gypsophiloides*)	Not assessed		Turkey, Iran (S-Iran, W-Iran), Iraq (NE-Iraq, NW-Iraq), Israel, Kuwait, Lebanon, Sinai peninsula & Syria
Dianthus crinitus	Not assessed		Turkey, Aegean Islands, N.W. Africa, Caucasia, Turkestan, Iran

Scientific name	IUCN (2019) status	Habitat of occurrence	Countries of occurrence according to IUCN (2019)
			Pakistan (eFlora.org, Date unknown).
Chrozophora tinctoria	Least Concern	Wetlands (inland), artificial/aquatic & marine	Afghanistan, Albania, Algeria, Bulgaria; Cyprus, Egypt; France, Greece, Iran, Italy, Kazakhstan, Lebanon, Libya, Morocco, Pakistan, Palestine, Portugal, Qatar, Romania; Saudi Arabia; Slovenia, Spain, Tunisia, Turkey, Turkmenistan, Ukraine & Yemen
Hypericum lysimachioides	Not assessed		Turkey, Iran & Iraq (NE-Iraq)
Phlomis bruguieri	Not assessed		Iran, Iraq, Lebanon-Syria & Turkey
Gagea reticulata (synonym *Gagea tenuifolia*)	Not assessed		Afghanistan, Algeria, Bulgaria, Egypt; Greece, Iran, Iraq, Kazakhstan, Kriti, Kuwait, Lebanon-Syria, Libya, North Caucasus, Pakistan, Palestine, Romania, Saudi Arabia, Sinai, South European Russi & Tadzhikistan Transcaucasus; Turkey; Turkmenistan; Ukraine; Uzbekistan; West Himalaya
Aegilops umbellulata	Least Concern	Artificial / terrestrial, grassland, marine coastal/supratidal, other & forest	Armenia, Azerbaijan, Cyprus, Greece, Iran, Iraq, Lebanon, Serbia, Syrian Arab Republic, Turkey & Turkmenistan
Aegilops speltoides	Least Concern	Artificial / terrestrial, forest & grassland	Bulgaria, Greece, Iran, Iraq, Israel, Jordan; Lebanon, Palestine, Syrian & Turkey
Avena sterilis subsp. *ludoviciana*	Least Concern	Artificial / terrestrial, rocky areas (e.g. inland cliffs, mountain peaks) & grassland	>30 countries including Iraq
Hordeum bulbosum	Least Concern	Grassland, shrubland, artificial / terrestrial	28 countries including Iraq
Hordeum murinum subsp. *glaucum*	Not assessed		>30 countries including Iraq
Phragmites australis	Not assessed	Forest, wetlands (inland), artificial / aquatic & marine	>70 countries including Iraq

Table A4.2 Species of avifauna recorded within the baseline survey area (2019)

Common name	Scientific name	IUCN (2019) status	Habitat of occurrence (IUCN, 2019)	Migratory Status	Congregatory Status
masked shrike	*Lanius nubicus*	LC	Forest, shrubland, savanna	Full migrant	Not congregatory
crested lark	*Galerida cristata*	LC	Marine Intertidal, Grassland, Shrubland, Artificial/Terrestrial, Artificial/Aquatic & Marine, Savanna	Full migrant	Not congregatory
house sparrow	*Passer domesticus*	LC	Forest, Rocky areas (eg. inland cliffs, mountain peaks), Wetlands (inland), Grassland, Artificial/Terrestrial, Artificial/Aquatic & Marine, Shrubland	Not a migrant	Not congregatory
common wood-pigeon	*Columba palumbus*	LC	Shrubland, Artificial/Terrestrial, Forest	Full migrant	Not congregatory
Isabelline wheatear	*Oenanthe isabellina*	LC	Marine Intertidal, Desert, Artificial/Terrestrial, Shrubland, Grassland, Rocky areas (eg. inland cliffs, mountain peaks)	Full migrant	Not congregatory
whinchat	*Saxicola rubetra*	LC	Artificial/Terrestrial, Shrubland, Grassland, Forest	Full migrant	Not congregatory
laughing dove	*Streptopelia senegalensis*	LC	Grassland, Artificial/Terrestrial, Savanna	Full migrant	Not congregatory
Hume's Wheatear	*Oenanthe albonigra*	LC	Shrubland, Rocky areas (eg. inland cliffs, mountain peaks).	Not a migrant	Not congregatory
common raven	*Corvus corax*	LC	Forest, Rocky areas (eg. inland cliffs, mountain peaks), Grassland, Shrubland, Artificial/Terrestrial	Not a migrant	Not congregatory
Eurasian magpie	*Pica pica*	LC	Forest, Rocky areas (eg. inland cliffs, mountain peaks), Grassland, Shrubland, Artificial/Terrestrial	Not a migrant	Not congregatory
Eastern rock nuthatch	*Sitta tephronota*	LC	Rocky areas (e.g. inland cliffs, mountain peaks), Wetlands (inland), Shrubland	Altitudinal migrant	Not congregatory
Eurasian kestrel	*Falco tinnunculus*	LC	Artificial/Terrestrial, Shrubland, Forest, Grassland	Full migrant	Congregatory (and dispersive)

black francolin	*Francolinus francolinus*	LC	Grassland, Artificial/Terrestrial, Shrubland	Not a migrant	Not congregatory
red-wattled lapwing	*Vanellus indicus*	Globally LC; VU in Europe	Forest, Wetlands (inland), Grassland, Artificial/Terrestrial	Not a migrant	Congregatory (and dispersive)
Iraq babbler	*Turdoides altirostris*	LC; NT in Europe	Wetlands (inland), Artificial/Terrestrial, Artificial/Aquatic & Marine	Not a migrant	Not congregatory
white-throated kingfisher	*Halcyon smyrnensis*	LC; VU in Europe	Marine Intertidal, Forest, Artificial/Terrestrial, Artificial/Aquatic & Marine, Wetlands (inland)	Not a migrant	Not congregatory
black kite	*Milvus migrans*	LC	Marine Coastal/Supratidal, Artificial/Terrestrial, Forest, Shrubland, Desert, Grassland, Marine Intertidal, Wetlands (inland), Savanna	Full migrant	Congregatory (and dispersive)
graceful prinia	*Prinia gracilis*	LC	Forest, Shrubland, Savanna, Artificial/Terrestrial	Not a migrant	Not congregatory
corn bunting	*Emberiza calandra*	LC	Grassland, Artificial/Terrestrial	Full migrant	Not congregatory
rufous-tailed scrub-robin	*Cercotrichas galactotes*	LC	Artificial/Terrestrial, Wetlands (inland), Grassland, Forest, Shrubland, Savanna	Full migrant	Not congregatory
hen harrier	*Circus cyaneus*	LC; NT in Europe	Artificial/Terrestrial, Wetlands (inland), Shrubland, Grassland, Forest	Full migrant	Congregatory (and dispersive)
see-see partridge	*Ammoperdix griseogularis*	LC	Desert, Rocky areas (eg. inland cliffs, mountain peaks), Shrubland	Not a migrant	Not congregatory
Spanish sparrow	*Passer hispaniolensis*	LC	Forest, Artificial/Terrestrial, Shrubland, Grassland	Full migrant	Congregatory (and dispersive)
Eurasian eagle-owl	*Bubo bubo*	LC	Caves and Subterranean Habitats (non-aquatic), Forest, Grassland, Shrubland, Artificial/Terrestrial	Not a migrant	Not congregatory
Eurasian collared-dove	*Streptopelia decaocto*	LC	Artificial/Terrestrial, Shrubland	Not a migrant	Not congregatory
cattle egret	*Bubulcus ibis*	LC	Forest, Wetlands	Full	Congregatory

			(inland), Grassland, Artificial/Terrestrial	migrant	(and dispersive)
Menetries's warbler	*Sylvia mystacea*	LC	Marine Intertidal, Desert, Shrubland, Savanna, Artificial/Terrestrial	Full migrant	Not congregatory
white wagtail	*Motacilla alba*	LC	Marine Intertidal, Artificial/Terrestrial, Grassland, Wetlands (inland), Desert	Full migrant	Not congregatory

APPENDIX 5
STAKEHOLDER ENGAGEMENT MATERIALS

PowerPoint Presentation

Khor Mor 250 Expansion Project

Pearl Petroleum

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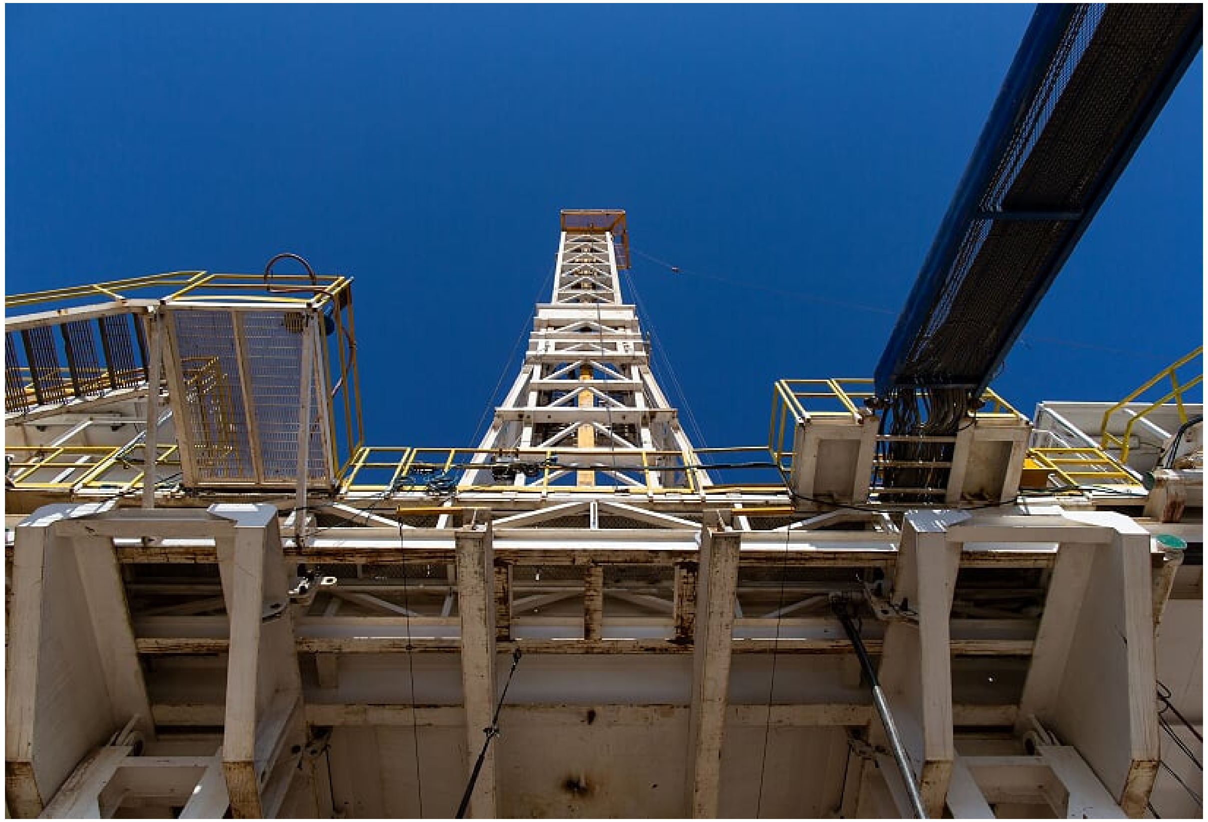
Objectives of Meeting

- Introduce the Environmental and Social Impact Assessment (ESIA) team
- Provide an overview of the Project
- Outline the ESIA process and ESIA report
- Provide opportunities to raise questions and concerns related to the Project and ESIA



Pearl Petroleum

- Formed as a consortium in 2009 with Dana Gas and Crescent Petroleum as shareholders

- The Austrian Mineral Oil Administration (OMV), the Hungarian Oil and Gas Public Limited Company (MOL) and the German RWE subsequently joined the consortium (with a ten per cent share each)

- Crescent Petroleum and Dana Gas operate major gas fields in Kurdistan (Chemchemal, Khor Mor and Block 19/20) as Operator on behalf of Pearl

The ESIA Team

- RSK – **the ESIA lead** – is a leading international environmental, social and engineering services company. A diverse team of environmental and social specialists from RSK will undertake the ESIA in collaboration with local specialists from national universities and NGOs.

- Hatch is a leading international management, engineering and development consultancy. Hatch has undertaken the **Front-End Engineering Design (FEED)** and will continue to provide support during the ESIA.

- The Operator will work with RSK and Hatch during the undertaking of the ESIA.

Khor Mor Existing Gas Processing Facility

- Close to the village of Khor Mor in the governorate of Sulaymaniyah (Kurdistan Region of Iraq)

- Constructed from 2007 – 2011

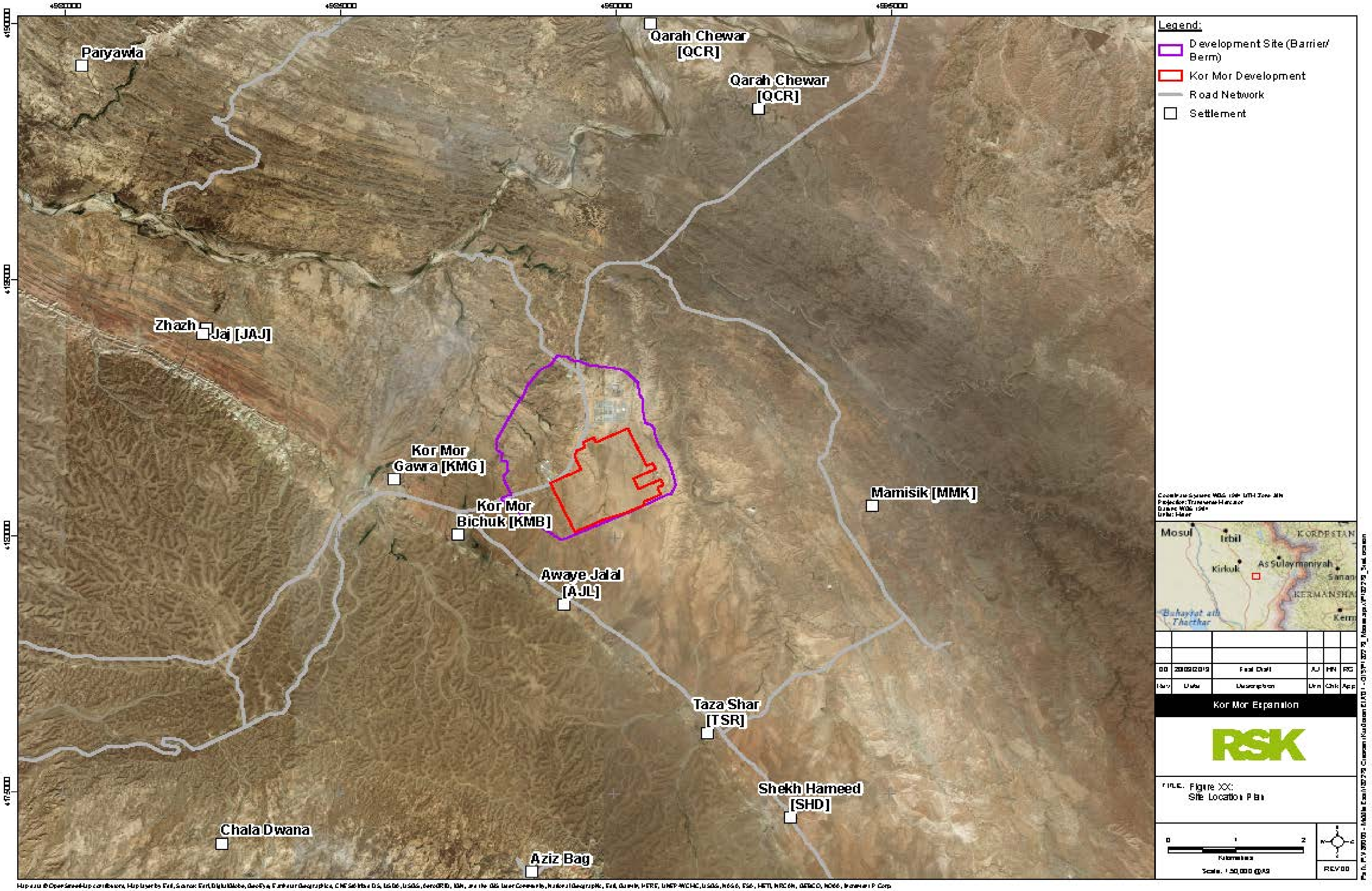
- 600 hectare (ha) site, 50 ha of which is currently occupied

- Extraction of hydrocarbon from the Khor Mor reservoir

- Separation of hydrocarbon into main products: natural gas, Liquified Petroleum Gas (LPG) and condensate

- Natural gas is transported to power stations in Chemchemal, Erbil and Sulaymaniyah

Khor Mor Existing Gas Processing Facility



Khor Mor Existing Gas Processing Facility

The Khor Mor 250 Expansion Project

Objectives:

- To contribute to the region's energy supply through more efficient, cleaner electricity generation

- To contribute to local employment and services provision

The Khor Mor 250 Expansion Project

- Construction of a new gas processing facility (within the existing site boundary), additional flowlines from new gas field production wells to the processing facility and supporting infrastructure

- Construction anticipated to start up by mid 2020, with completion and first production of gas/liquids by early 2022

- Requirement of an ESIA by the Ministry of Natural Resources (MNR)

Overview of the ESIA Process

SCOPING

The aim of this phase is to identify the scope of the ESIA, the study area, available information and high-level potential impacts that need to be further evaluated during the ESIA.

BASELINE STUDIES

Baseline studies are undertaken to understand the local socio-economic and natural environment. Specialists speak to people and carry out research in local communities to better understand the environment and the way people live.

IMPACT ASSESSMENT

Based on the baseline studies, the potential impacts and benefits of a project are identified and evaluated in terms of the significance of their effects on people, their livelihoods and the natural environment.

MITIGATION AND MANAGEMENT

Mitigation measures are recommended to avoid or reduce the negative impacts identified in the impact assessment and maximise the potential positive benefits. These are included in management plans for the project.

DISCLOSURE

The draft ESIA report containing conclusions regarding possible impacts is submitted to the national regulators who provide feedback and may request additional studies or changes. The outcomes of the ESIA are also presented to stakeholders.

REGULATORY APPROVAL

The revised ESIA Report is submitted to the national regulators for approval, which is required for the project to proceed.

Regulatory and Institutional Framework for ESIA

- **Legislative requirements of the KRG**
    - *Instructions (No. 1) of 2015 on the Environmental Impact Assessment of Petroleum Operations*
    - *Technical Guidelines on the Environmental Impact Assessment of Petroleum Operations in the Kurdistan Region of Iraq*

- **International best practice**
    - *International Finance Corporation's (IFC's) Performance Standards (PS) on Environmental and Social Sustainability (2012)*
    - *IFC Environmental, Health and Safety (EHS) Guidelines*

- **Operator's internal corporate standards and requirements**
    - *Quality, Health, Safety, Security and Environment (QHSSE) Policy Statement*
    - *Social Performance Standard*

Baseline Studies

Information on local socio-economic and environmental conditions will be obtained via:

- Previous ESIAs submitted in Kurdistan
- Secondary sources (desktop research)
- Primary baseline data collection:
  - Physical environment surveys (air quality, noise)
  - Biodiversity surveys (fauna, avifauna, habitats, flora)
  - Socio-economic surveys (local communities, village Anjuman, health staff, teachers)

Impact Assessment, Mitigation and Management

- Potential for the Project to impact the physical environment (e.g. air, water), socio-economic environment (e.g. people, economy) and the ecological environment (e.g. flora, fauna)

- Impacts with high or moderate significance warrant mitigation measures to reduce them to as low as reasonably practicable (ALARP) and maximise any potential benefits

- Approach taken to identify and incorporate mitigation measures for the Project is based on the best practice hierarchy of decisions and measures in order of priority, as follows:
    - Avoid at source/reduce at source
    - Abate on site
    - Abate off-site/at receptor
    - Repair or remedy

- Mitigation measures identified in the ESIA will be implemented via an Environmental and Social Management Plan (ESMP) during Project implementation

Stakeholder Engagement

- **Objectives:**
  - To inform stakeholders about the Project and ESIA
  - To obtain the input of stakeholders into Project impact identification and management
  - To provide opportunities for stakeholders to express Project- and ESIA-related opinions and concerns
  - To provide feedback to stakeholders on the findings of the ESIA study

Grievance Management Procedure

Objective:

- To ensure that stakeholders have an easy means of lodging grievances related to the Khor Mor 250 Expansion Project and ESIA and to ensure that there will be a follow-up.

Using the Grievance Management Procedure

1. Report your grievance to Operator's Social Performance Department (SPD).

2. The SPD will investigate your grievance. Additional information may be requested from yourself (or other individuals, where relevant) at this time.

3. The findings of the investigation and a proposed resolution will be discussed with you.

4. If you accept the resolution, it will be implemented as quickly as possible. If you reject the resolution, your grievance will be escalated to an Appeals Committee for review and eventual resolution.

5. Following implementation of the resolution, you will be notified by the SPD and the grievance will be officially closed out.

Note that further details on reporting grievances will be provided to community leaders.

Description of the ESIA report

Key sections of the ESIA report will include:

- Description of the proposed Project, including operations and activities
- Baseline characteristics of the socio-economic and natural environment within the expected area of influence
- Potential impacts of the Project
- Mitigation measures
- Relevant national regulations and international requirements
- Environmental and social management plan

Timeline

Indicative dates for the ESIA:

- Undertaking of the ESIA and preparation of the draft ESIA report – August 2019 to December 2019
- Disclosure of the draft ESIA report and submission of the final ESIA report – January 2020

Q&A

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Posters



KHOR MOR 250 EXPANSION PROJECT

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Crescent Petroleum

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DANAGAS

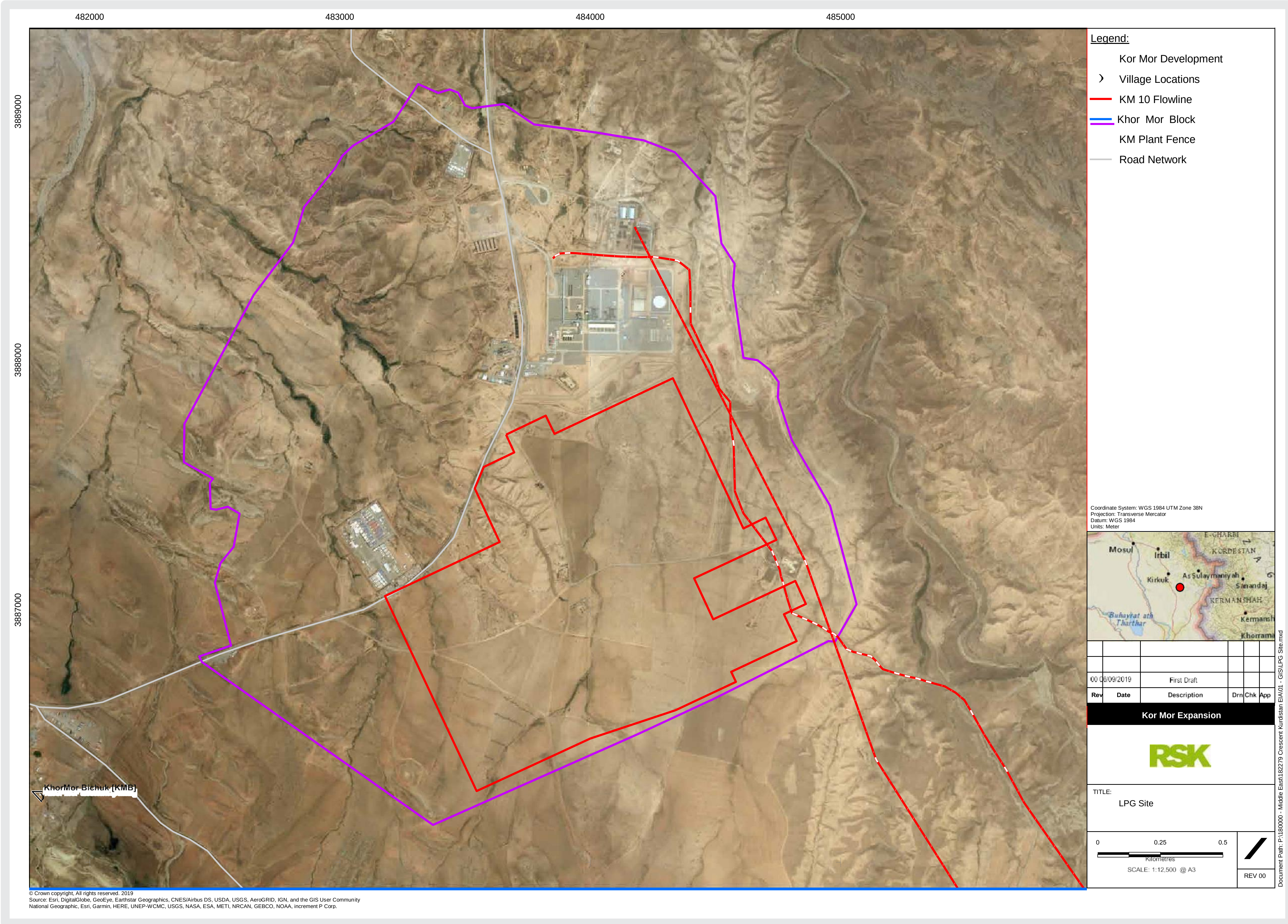
Khor Mor 250 Expansion Project - What We Do

Pearl Petroleum operates the Khor Mor gas facility located close to the village of Khor Mor in the governorate of Sulaymaniyah in the Kurdistan Region of Iraq.

This facility extracts hydrocarbon from the Khor Mor reservoir, which was first discovered in the 1930s. The hydrocarbon is then separated into:

- Natural gas
- Liquified Petroleum Gas (LPG)
- Condensate.

The gas is used in power stations in Chemchemal, Sulaymaniyah and Erbil to produce more efficient, cleaner electricity.



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Khor Mor 250 Expansion Project - What we are doing to expand production

The Khor Mor 250 Expansion Project is a natural extension to the existing facility at Khor Mor.

The Project involves the construction of a new gas processing facility inside the existing site, alongside new flowlines from new gas wells near the facility. There will also be new supporting infrastructure outside the site boundary.

Once completed, the Project will increase production at the site, contributing further to the region's energy supply and providing local employment and services opportunities in the Kurdistan Region of Iraq.

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Khor Mor 250 Expansion Project - What are the key components?

- New gas processing facility
- New well flowlines
- A Central Control Building and Laboratory
- New site utilities and power generation
- Construction workshops, yards, offices and accommodation camp

Khor Mor 250 Expansion Project – What this means for you

- Physical environment
- Socio-economic environment
- Ecological environment

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Khor Mor 250 Expansion Project – Environmental and Social Impact Assessment (ESIA) Process

SCOPING

The aim of this phase is to identify the scope of the ESIA, the study area, available information and high-level potential impacts that need to be further evaluated during the ESIA.

BASELINE STUDIES

Baseline studies are undertaken to understand the local socio-economic and natural environment. Specialists speak to people and carry out research in local communities to better understand the environment and the way people live.

IMPACT ASSESSMENT

Based on the baseline studies, the potential impacts and benefits of a project are identified and evaluated in terms of the significance of their effects on people, their livelihoods and the natural environment.

MITIGATION AND MANAGEMENT

Mitigation measures are recommended to avoid or reduce the negative impacts identified in the impact assessment and maximise the potential positive benefits. These are included in management plans for the project.

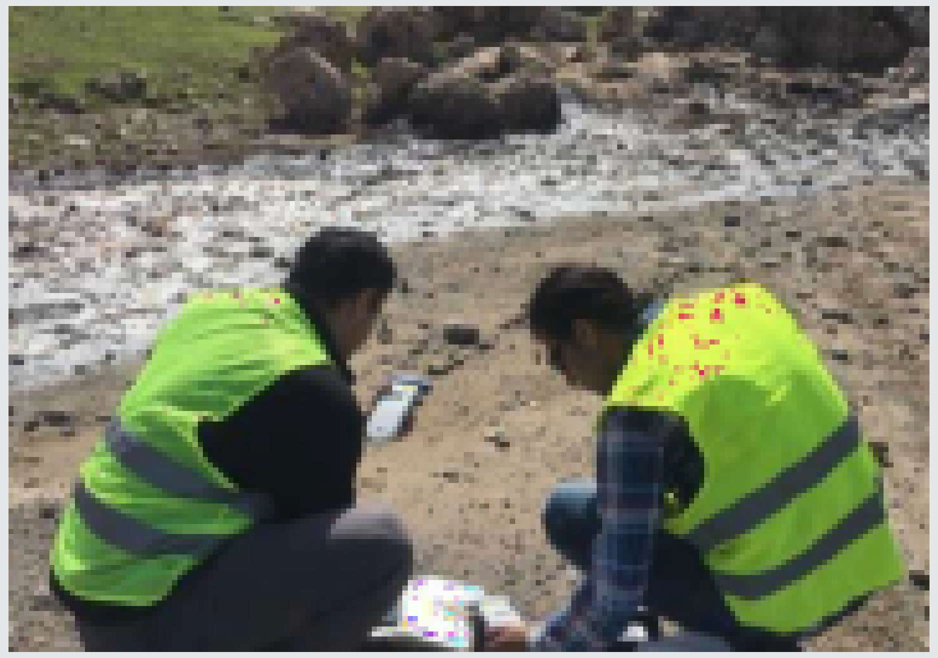
DISCLOSURE

The draft ESIA report containing conclusions regarding possible impacts is submitted to the national regulators who provide feedback and may request additional studies or changes. The outcomes of the ESIA are also presented to stakeholders.

REGULATORY APPROVAL

The revised ESIA Report is submitted to the national regulators for approval, which is required for the project to proceed.

STAKEHOLDER ENGAGEMENT



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Khor Mor 250 Expansion Project - We would like to hear from you if you have any questions.

If you have any questions or would like to report an issue, you can speak to a member of Pearl Petroleum's Social Performance Department when they visit your community, or you can contact call them on:

Tel: 0773 085 0929

Tel: 0773 667 0641

Email: kmseo2@crescent.ae

START

Report your grievance

Pearl's Social Performance Department (SPD) will investigate as quickly as possible.
Additional information may be requested from you (or other individuals) at this time.

The findings of the investigation and a proposed resolution will be discussed with you.

DO YOU ACCEPT THE RESOLUTION?

You YES

Your grievance will be escalated to an Appeals Committee for review.

Following implementation, you will be notified by the SPD and your grievance will be officially closed.

END

NO

Your grievance will be escalated to an Appeals Committee for review.

The Appeals Committee will propose additional actions or an alternative resolution. If you do not agree, you are entitled to take legal action and the final decision will be taken by the arbitrator or courts.

END

Background Information Document (BID)

Khor Mor 250 Expansion Project

Background Information Document

Pearl Petroleum was founded in 2009 and is jointly owned by five shareholders, the largest being Dana Gas and Crescent Petroleum. The company operates major gas fields in Kurdistan (Chemchemal, Khor Mor and Block 19/20)

The company is planning to expand its existing gas facility – Khor Mor – located close to the village of Khor Mor in the governorate of Sulaymaniyah in the Kurdistan Region of Iraq.

The Project will involve the design, procurement and construction of a new gas processing facility capable of processing and producing natural gas and liquid products.

Project Information

The Khor Mor 250 Expansion Project is a natural extension to the existing facility at Khor Mor. The existing facility extracts hydrocarbon from the Khor Mor Reservoir, which is then separated into natural gas, Liquified Petroleum Gas (LPG) and condensate. Natural gas is transported from the existing facility to power stations in Chemchemal, Sulaymaniyah and Erbil. The site currently has a total of seven production wells; four are located within the site boundary and three are located outside the site boundary.

The Khor Mor 250 Expansion Project involves the construction of a new gas processing facility within the existing site boundary, alongside new flowlines (from new production wells to the new processing facility) and new supporting infrastructure outside the site boundary.

In addition, the Project will include the following components:

- new well flowlines
- a Central Control Building and Laboratory
- new site utilities and power generation
- construction workshops, yards, offices and accommodation camp.

Once completed, the Project will increase the production of gas and liquid products at the site, contributing further to the region's energy supply through more efficient, cleaner electricity generation and providing local employment and services opportunities in the Kurdistan Region of Iraq.

Environmental and Social Impact Assessment (ESIA)

In line with national legislation and international standards, an ESIA of the Khor Mor 250 Expansion Project will be undertaken.

The ESIA will require completion of various studies and engagement with stakeholders to ensure it meets international standards.

The ESIA will identify potential impacts, both positive and negative, and recommend actions to manage potential significant negative impacts and maximise positive benefits.

Stakeholder engagement is an important part of the ESIA process and a national requirement. Stakeholder engagement involves sharing Project information with stakeholders. Engagement meetings will provide an opportunity for stakeholders to ask questions and make comments about the Project, and to listen and respond to their concerns via the ESIA process.

The ESIA Process

Scoping

The aim of this phase is to identify the scope of the ESIA, the study area, available information and high-level potential impacts that need to be further evaluated during the ESIA.

Baseline Studies

Baseline studies are undertaken to understand the local socio-economic and natural environment. Specialists speak to people and carry out research in local communities to better understand the environment and the way people live.

Impact Assessment

Based on the baseline studies, the potential impacts and benefits of a project are identified and evaluated in terms of the significance of their effects on people, their livelihoods and the natural environment.

Mitigation and Management

Mitigation measures are recommended to avoid or reduce the negative impacts identified in the impact assessment and maximise the potential positive benefits. These are included in management plans for the project.

Disclosure

The draft ESIA report with conclusions regarding possible impacts is submitted to the national regulators who provide feedback and may request additional studies or changes. The outcomes of the ESIA are also presented to stakeholders.

Regulatory Approval

The revised ESIA report is submitted to the national regulators for approval, which is required for the project to proceed.

How will you be involved?

During the ESIA Process

During the ESIA process, government authorities, civil society, educational institutions and local communities are engaged with through individual, small group and community meetings.

The purpose of these meetings is to provide you with details about the Khor Mor 250 Expansion Project and ESIA, obtain your input into the ESIA and seek your opinions and concerns about the Project and ESIA.

After the Completion of the Draft ESIA Report

After the completion of the draft ESIA report, the same individuals, groups and communities will be met with, in addition to any other stakeholders identified during the ESIA.

The purpose of these meetings is to provide you with a summary of the findings of the ESIA study, especially the identified impacts and mitigation measures, and obtain your feedback on these findings so that they can be included in the final ESIA report.

Potential Benefits and Impacts

- physical environment
- socio-economic environment
- ecological environment

Grievance Management Procedure

A grievance management procedure has been established to provide you with an easy means of reporting any grievance related to the Khor Mor 250 Expansion Project and ESIA.

To report a grievance, please speak to a member of Pearl's (Dana Gas') Social Performance Department (SPD) when they are in your community or contact them on:

Tel: 0773 085 0929

Tel: 0770 667 0641

Email: kmseo2@crescent.ae

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APPENDIX 6
IMPACT ASSESSMENT CRITERIA TABLES

Table A6.1: Criteria for determination of magnitude of potential environmental and social impacts on each receptor[1]

Receptor	Impact type	Impact magnitude rating			
		Slight	Low	Medium	High
Air quality	Un-degraded airshed	Project contribution < 25% of AAQS (see Project standards for air quality)	Project contribution between 25% and 50% of AAQS and predicted environmental concentration < 100% of AAQS	Project contribution between 25% and 50% of AAQS and predicted environmental concentration > 100% of AAQS or Project contribution between 50% and 100% of AAQS and predicted environmental concentration < 100% of AAQS	Project contribution between 50% and 100% of AAQS and predicted environmental concentration > 100% of AAQS or predicted environmental concentration > 100% of AAQS
	Degraded or ecologically sensitive airshed	Project contribution < 10% of AAQS	Project contribution between 10% and 15% of AAQS	Project contribution between 15% and 25% of AAQS	Project contribution greater than 25% of AAQS
Daytime noise levels ($L_{eq\ 1hr}$ dBA) during construction	All daytime exposure periods	<65	65-70	>70-75	>75
Night-time noise levels ($L_{eq\ 1hr}$ dBA) during construction	All daytime exposure periods	<50	50-55	>55-60	>60
Daytime noise levels ($L_{eq\ 1hr}$	Noise disturbance	<40	40-45	>45-50	>50

[1] This concerns conventional air pollutants with local and / or regional impact. GHGs are handled differently, as per the overview of methodology in the body of the report.

Receptor	Impact type	Impact magnitude rating			
		Slight	Low	Medium	High
dBA) during operation	impact magnitude				
	Amenity impact magnitude	<5	5-10	>10-15	>15
Night-time noise levels ($L_{eq\ 1hr}$ dBA) during operation	Noise disturbance impact magnitude	<35	35-40	>40-45	>45
	Amenity impact magnitude	<5	5-10	>10-15	>15
Soil	Soil erosion	Disturbance of soils with low erosion potential in landscapes with slopes <4%	Less than 25% of soils disturbed have a medium or high erosion potential and are in landscapes with slopes 4% to 30%	25% to 50% of soils disturbed have a medium or high erosion potential and are in landscapes with slopes 4% to 30%	More than 50% of soils disturbed have a medium or high erosion potential and are in landscapes with slopes 4% to 30%
	Riparian erosion (see also Surface Water)	No perceptible or readily measurable change from baseline riparian erosion rates	Perceptible change in baseline riparian erosion rates	Clearly evident (i.e. perceptible and readily measurable) change from baseline riparian erosion rates, but affecting a small geographic area	Major (i.e. order of magnitude) change from baseline riparian erosion rates, and affecting a large geographic area
	Loss of land/soils used for agriculture	No impact to soils that are used for agriculture	Less than 25% of the soils impacted are used for agriculture	Between 25% to 50% of the soils impacted are used for agriculture	Greater than 50% of the soils impacted are used for agriculture
	Soil quality	Alteration of chemical composition of soil by adding toxic material, slight increase in total contaminative potential. Concentrations not	Increase in concentration of organic or inorganic compounds or other contaminants in soil presenting a minor risk to environmental, biological	Degradation of soil quality providing ongoing contamination source and/or resulting in high risk to potential receptors, including	Degradation of soil quality providing ongoing contamination source and/or resulting in high risk to potential receptors. Concentrations exceeding

Receptor	Impact type	Impact magnitude rating			
		Slight	Low	Medium	High
		exceeding guideline values.	and human (site users only) receptors. Concentrations exceeding investigation levels. Effects confined within the Project footprint or to a small, isolated location(s) outside the Project area.	local community. Concentrations exceeding investigation levels. Effects extend beyond the area of disturbance to the surrounding area but are contained within the general area.	investigation levels. Effects are widespread.
	Topography and drainage characteristics	Changes to site profiles or elevations (<±0.5 m), and/or compaction or disturbance of surface soils / placement of hard-stand not resulting in measurable alteration to drainage characteristics	Changes to site profiles or elevations (<±1 m), and/or compaction or disturbance of surface soils / placement of hard-stand not resulting in measurable alteration to drainage characteristics	Earthworks altering profiles and elevations (<±3 m); and/or placement of hard-stand or poorly managed drainage system resulting in alteration of drainage characteristics	Alteration of existing profiles great enough (>±3 m) to impact neighbouring land (e.g. drainage flows onto neighbouring land), subsidence, and/or placement of hard-stand and/or poorly managed drainage system resulting in alteration of drainage characteristics
	Subsurface lithology	Addition of foundation materials, reworking or removal of soils altering a shallow low-sensitivity geological succession.	Addition of foundation materials, reworking or removal of soils altering a shallow medium-sensitivity geological succession.	Addition of foundation materials, reworking or removal of soils altering a shallow high-sensitivity geological succession.	Mining or exploitation of geological formations (e.g. quarrying activities).
Hydrogeology	Groundwater quality and spatial extent	Groundwater quality impacts are likely to be well within ambient ranges or Iraq standards and isolated in extent (i.e. <1ha)	Groundwater quality impacts are likely to be well within ambient ranges or Iraq standards and localised in extent (i.e. 1 to 10ha)	Groundwater quality impacts are likely to result in occasional exceedances of ambient ranges or Iraq standards and extend area-wide (i.e. 10 to 100ha)	Groundwater quality impacts are likely to routinely or permanently exceed ambient ranges or Iraq standards over large areas (i.e. >100ha)
	Duration	Short-term, localised	Short-term, localised effects	Localised effects on	Severe effects on groundwater

Receptor	Impact type	Impact magnitude rating			
		Slight	Low	Medium	High
		effects on groundwater quality, but likely to be highly transitory (e.g. lasting a matter of hours) and well within natural fluctuations	on groundwater quality, but which are likely to return to equilibrium conditions within a short timeframe (i.e. hours or days at most)	groundwater quality that are likely to be reasonably long lasting (e.g. weeks or months) and/or give rise to indirect ecological and/or socio-economic impacts	quality that are likely to be long lasting (e.g. months or more) or permanent, and/or give rise to indirect ecological and/or socio-economic impacts
	Groundwater Resource and Availability	There are no known or expected groundwater users within the likely area of influence of Project abstraction boreholes.	There are known or expected groundwater users within the likely area of influence of Project abstraction boreholes, but their supplies may not be reduced by the Project.	There are known or expected groundwater users within the likely area of influence of Project abstraction boreholes, and their supplies may be reduced by the Project	There are known or expected groundwater users within the likely area of influence of Project abstraction boreholes, and their supplies will be affected by the Project
Surface water	Surface water features	Changes to surface water features (e.g. reworking or removal of soil or structures, addition of access roads and tracks, increased traffic) not leading to measurable changes in the surface water system (i.e. rivers, streams or canals)	Changes to surface water features (e.g. reworking or removal of soil or structures, addition of access roads and tracks, increased traffic) leading to localised (i.e. 1 to 10ha) changes in flow pathways during the rainy season	Changes to surface water features (e.g. reworking or removal of soil or structures, addition of access roads and tracks, increased traffic) leading to area-wide (i.e. 10 to 100ha) changes to preferential flow pathways during the rainy season, or resulting in diversion works	Changes to surface water features (e.g. reworking or removal of soil or structures, addition of access roads and tracks, increased traffic) leading to widespread (i.e. >100ha) alteration of surface water bodies, changes to preferential flow pathways and regime during the rainy season, or resulting in large scale re- diversion works
	Flow Rate	Decrease in surface water flow downstream of project asset not discernible by local users at any time of the year.	Decrease in surface water flow downstream of project asset is likely to be discernible by local users but is unlikely to cause	Decrease in surface water flow downstream of project asset is sufficient to cause complaints from local	Decrease in surface water flow downstream of project asset is likely to cause users to use less water than they normally use and to seek one or more

Receptor	Impact type	Impact magnitude rating			
		Slight	Low	Medium	High
			users to use less water than they normally use at any time of year.	users but is unlikely to cause users to use less water than they would normally use or to seek a supplementary source of water at any time of year.	supplementary sources of water to make up the deficit during the dry season.
	Surface water quality	Reduction in water quality (suspended sediment, turbidity, colour, odour and taste) downstream of project asset not discernible by local users at any time of year. Concentrations not exceeding Iraq standards	Reduction in water quality (suspended sediment, turbidity, colour, odour and taste) downstream of project asset is likely to be discernible by local users but is unlikely to cause users to use less water than they normally use or to seek supplementary sources of water at any time of year. Concentrations not exceeding Iraq standards	Reduction in water quality (suspended sediment, turbidity, colour, odour and taste) downstream of project asset is sufficient to cause complaints from local users but is unlikely to cause users to use less water than they would normally use or to seek supplementary sources of water at any time of year. Concentrations exceeding Iraq standards	Reduction in water quality (suspended sediment, turbidity, colour, odour and taste) downstream of project asset is likely to cause users to use less water than they normally use and to seek supplementary sources of water to make up the deficit at all times of the year. Concentrations exceeding Iraq standards
Biodiversity	Flora and fauna	Disruption of behaviour or species interactions that is barely detectable with respect to natural variability	Minor disruption of behaviour or species interactions not impacting overall health/integrity of the population of the species. Affects a specific group of localised individuals within	Moderate disruption of behaviour or species interactions Affects a portion of a population and may bring about a change in abundance and/or distribution over one or	Affects an entire population or species in sufficient magnitude to cause a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would

Receptor	Impact type	Impact magnitude rating			
		Slight	Low	Medium	High
			a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself	more generation, but does not threaten the integrity of that population or any population dependent on it	not return that population or species, or any population or species dependent upon it, to its former level within several generations Introduction of alien invasive species
	Habitats	Disruption of habitat is barely detectable with respect to natural variability	Minor shift away from baseline conditions. Direct or indirect impacts will be discernible but underlying character composition and/or attributes of baseline condition will be similar to pre development circumstances or patterns. Approximately 1 to 5% of a habitat affected within the Project AOI	Post-development character, composition, and/or attributes of baseline habitat will be partially changed but the overall integrity of the habitat is not threatened Approximately 5 to 20% of a habitat is within the Project AOI	Post-development character, composition, and/or attributes of baseline habitat will be fundamentally changed and the overall integrity of the habitat or species within it are threatened Approximately 20 to 100% of a habitat is within the Project AOI
	Protected areas or proposed protected areas	N/A	No change in status of protected area or proposed protected area	Change in classification of protected area or proposed protected area to a lower level of protection	Delisting of protected area or proposed protected area
	Ecosystem services	Disruption of ecosystem service is barely detectable with respect to natural variability	The Project results in a small reduction in the availability or functionality of the ecosystem service, and/or has implications for a small number of people relative to the population within the Project AOI There is a perceptible	The Project results in a moderate reduction in the availability or functionality of the ecosystem service, and/or has implications for a substantial number of people relative to the population within the	The Project results in the loss of all or a significant proportion of the availability or functionality of an ecosystem service, and/or has implications for the majority of people within the Project AOI The long-term viability of the service is threatened

Receptor	Impact type	Impact magnitude rating			
		Slight	Low	Medium	High
			difference from baseline conditions.	Project AOI Does not threaten the long-term viability of the service.	
Socio-economic	Job creation	Job creation benefits are barely detectable to stakeholders in surrounding communities	Local job creation meets, but does not exceed local expectations	Job creation, although significant, falls short of local expectations, contributing to community dissatisfaction; or local job creation improves income levels, but not for all sections of the population	Unfulfilled expectations of job creation leading to demonstrations, sabotage, and contributing to social unrest Significant generation of local employment, resulting in long-term local economic improvement and community benefits
	Livelihoods of local populations	Impacts to livelihoods are barely detectable to stakeholders in surrounding communities	Small changes to livelihood, with only minor impacts on productivity or profitability which are neither sufficient to make those livelihood activities unviable, nor (if impacts are positive) sufficient to attract competitors in that sector	Partial restriction of access to livelihood resources, or markets, which results in changes to productivity or profitability	Complete loss of livelihood resources attributable, or perceived to be attributable to the Project, involuntary relocation of households, businesses or productive resources
	Quality of life for local residents and communities	Impacts on quality of life are barely detectable to stakeholders in surrounding communities	Perceptions of air quality, noise, vibration, dust, light pollution or other nuisances contribute to low-level community dissatisfaction, irrespective of measured data or applicable legal or agreed limits	Air quality noise, dust, vibration, dust, light pollution or other impacts cause noticeable and serious interference with daily life, irrespective of measured data or applicable legal or agreed limits	Severe deterioration in the living environment due to Project impacts ion air quality noise, dust, vibration, dust or light pollution, irrespective of measured data or applicable legal or agreed limits

Receptor	Impact type	Impact magnitude rating			
		Slight	Low	Medium	High
	Social cohesion	Project impacts on social cohesion with surrounding communities are barely detectable	Low-level discord between incoming workers or contractors, migrants and local communities, resulting in loss or reduced levels of trust.	Minor increase in social pathologies, including antisocial behaviour, vandalism, crime, alcohol / drug abuse, thefts, minor acts of violence, prostitution Incoming workers' families subject to unfair treatment, discrimination or lack of opportunities	Severe social cohesion problems, inter-ethnic tensions or violence, threats to security and safety, potentially resulting in work stoppages or delays, or threats to productivity
	Local economy, markets and prices	Impacts on prices for local goods and services are barely detectable	Seasonal and/or minor localised price impacts (inflation or deflation) on food and consumables, due to market re-adjustments accompanying incoming workforce and their families	Significant price impacts attributed to the Project, resulting in changes to overall standards of living	Major economic impacts: significant overall impacts on local market prices and availability of goods, including housing, services and consumables
	Transportation	N/A	No travel pattern or travel time change to local population. No disruption to safe transport of people, goods and material or animals	Limited effect on travel pattern or travel time and safe transport of goods, material and animals (i.e. effect on travel time and cost can be tolerated by users) Low cost transport network improvement will be required	Significant effect on travel pattern or travel time and on safe transport of people, goods, material and animals Effect on travel time and cost cannot be tolerated by users and authority intervention will be required (e.g. road improvement, subsidies, alternative transport)
	Reputation	Local public awareness but no discernible concern No media coverage	Local public concern Local media coverage	Regional public concern Local stakeholders, e.g. community, NGO, industry and government, are aware	National public concern Impact on local and national stakeholder relations. National government and NGO involvement with potential for

Receptor	Impact type	Impact magnitude rating			
		Slight	Low	Medium	High
				Extensive attention in local media. Some regional or national media coverage	international NGO action Extensive attention in national media. Some international coverage Potential for regulatory action leading to restricted operations or impact on operating licences
	Conditions of employment (includes contractors and suppliers)	Conditions of employment generally comply with international (especially ILO) and KRG requirements, with occasional minor exceptions (e.g. occasional missed attendance at school).	Disagreements over employment conditions resulting in tense worker-management relationships, lack of cooperation and less than optimal productivity Employees or workers required to pay employment agents fees Perception of unequal pay for similar work (e.g. nationalities, women, different contractors)	Poor worker-management relationships, resulting in partial (one or more, but not all contractors) temporary work stoppages or disruptions School-age children consistently missing school due to Project-related work.[2] .	Serious labour unrest - demonstrations, strikes or sabotage, resulting in production delays or losses.
	Recruitment methods	Dissatisfaction regarding recruitment methods is barely detectable within stakeholders in surrounding communities	Dissatisfaction with transparency of recruitment procedures, wage levels or conditions offered, contributing to decline in trust	Recruitment perceived to be biased in favour of selected tribal / ethnic groups, contributing to community tensions	Serious inter- or intra-community unrest attributed to recruitment bias in favour of one or more groups (justified or otherwise)
	Site security and community safety	Dissatisfaction regarding site security and community safety is barely	Potential safety hazard (unattended plant, unfenced equipment dump, etc.)	Minor accident, attributed by the community (with or	Severe injury or fatal accident, attributed by the community (with or without justification) to

[2] ILO guidelines hold that children over twelve years of age may, outside the hours fixed for school attendance, be employed on light work which is not such as to prejudice their attendance at school or their capacity to benefit from the instruction there given.

Receptor	Impact type	Impact magnitude rating			
		Slight	Low	Medium	High
		detectable within stakeholders in surrounding communities	causing community anxiety	without justification) to lack of due care on the part of the Project	the Project
Archaeology	Archaeology and cultural heritage	Negligible or slight changes to the setting of an archaeological or cultural heritage asset or group of assets	None or very limited impacts to archaeological or other cultural heritage resources, to the extent that the asset(s) is marginally altered Impacts limited to non-critical resources Minor changes to the setting of an archaeological or cultural heritage asset or group of assets	Some degradation of archaeological or other cultural heritage resources Clear modification of critical resources so that the archaeological or cultural heritage asset is Considerable changes to the setting of an archaeological or cultural heritage asset or group of assets	Permanent or irreversible loss or degradation of critical archaeological or other cultural heritage resources Comprehensive changes to the setting of an archaeological or cultural heritage asset or group of assets

Notes

AAQS = ambient air quality standards

Un-degraded airshed: baseline < AAQS.

Degraded airshed: baseline > AAQS and/or ecologically sensitive habitats.

$L_{eq\ 1hr}$ = equivalent continuous sound pressure level over a one-hour period.

Amenity impact magnitude: incremental increase above background levels ($L_{eq\ 1\ hour} - L_{90\ 1\ hour}$) where background noise level is greater than 30 dB(A) L90 during the night and 35 dB(A) L90 during the daytime.

Impact magnitude for operational noise is based on sensitive receptors in predominantly residential or rural areas. Where residential areas are located within commercial/industrial districts or on the main road, a relaxation to the operational phase impact magnitude of 10 dB(A) will apply e.g. worker's camps. This follows the principles of Kurdistan local standards (add cross reference).

'<' = less than.

'>' = greater than.

Table A6.2: Sensitivity criteria for the potential environmental and social impacts/receptors

Receptor/impact	Sensitivity criteria		
	Low	Medium	High
Air quality	Receptors where sensitivity to air pollution is minimal, e.g. industrial areas and desert.	Receptors moderately sensitive to air pollution, where it may cause some disturbance, e.g. agricultural areas.	Receptors where people or habitats are particularly susceptible to air pollution, e.g. residential areas, schools, healthcare clinics and ecologically sensitive areas.
Noise	Receptors where sensitivity to distraction or disturbance from noise is minimal, e.g. industrial areas, desert.	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance, e.g. agricultural areas.	Receptors where people or habitats are particularly susceptible to noise, e.g. residential areas, schools, healthcare clinics and ecologically sensitive areas.
Soil erosion	Soils with low erosion potential, and/or are resistant to compaction and scarring.	Soils with medium and/or high erosion potential that drain to water resources that support diverse aquatic habitats or are a locally important source of potable water for communities living nearby, and/or the surface is prone to compaction and scarring.	Soils with medium and/or high erosion potential that drain to water resources that support economically important or ecologically significant aquatic species or provide essential habitat for those species or are a locally important source of potable water for communities living nearby, and/or are sensitive to compression.
Riparian erosion	Flat sloped, shallow and/or well vegetated riparian zones	Riparian zones with medium slopes and some vegetation	Steep riparian zones with limited or no vegetation
Loss of land/soils used for agriculture	Soils that are not suitable for agriculture, i.e. desert soils of low fertility without available water supply	Soils that are suitable for agricultural use, but are used for grazing and limited subsidence agriculture, or are located in an area not intended for agricultural use	Soils that are used for agricultural production or are located in an area that is regionally important for agricultural production
Soil quality	Soils of no geological, ecological or economic value, and/or soils that have the ability to recover quickly	Soils of moderate geological, ecological or economic value, and/or soils that have the ability to recover only over multiple seasons.	Soils of important geological, economic or ecological value, and/or soils that have the ability to recover only over many seasons.
Hydrogeology	The groundwater resource has little to no role in terms of supply services for local communities	The groundwater resource has local importance in terms of supply, but there is ample capacity and/or adequate opportunity for alternative sources of	The groundwater resource has local importance in terms of supply, with no suitable technically or economically feasible alternatives, or is important at a regional or

Receptor/impact	Sensitivity criteria		
	Low	Medium	High
		comparable quality	trans-boundary watershed level for supply
Surface waters	Water non-potable and unsuitable for irrigation or watering livestock No use for navigation or industry Water supply meets local needs and there is no shortfall of resources	Water non-potable for humans but suitable for irrigation and watering livestock Water used for navigation, industry or agriculture and human needs Water supply does not meet local needs	Water is used for industrial, irrigation, watering livestock or potable uses Supports human needs Area lacking water resources
Flora and fauna	Species are not protected or listed Species are abundant / common and not critical for ecosystem functions Areas of little or no vegetation	Species are globally common but are rare in Iraq, or important to ecosystem functioning (e.g. predator / prey species), or a species that is under threat or has a declining population Species listed as Near Threatened by IUCN.	Regionally significant populations of globally threatened or endangered species (i.e. listed as Vulnerable, Endangered or Critically Endangered species by IUCN), which are or are likely to be found within the Project AOI, and are likely affected by the Project Species important to ecosystem functioning, such as predator or prey species
Habitats	Sites of local biodiversity value that are not intact, fragile or unique. May include wildlife corridors Habitats that recover quickly following disturbance (i.e. habitats comprising species that readily re-colonise disturbed areas) Habitats that can be classified as 'modified' in accordance with IFC Performance Standard 6 (IFC, 2012)	Habitats that are suffering significant decline at a national or regional level Areas of high species or habitat diversity, or 'naturalness' Habitats that are capable of unassisted recovery to natural conditions following disturbance, although this may require several years (e.g. reed beds and other habitats where growing conditions are favourable) Habitats that can be classified as 'natural' in accordance with IFC Performance Standard 6 (IFC, 2012)	Sites designated for protection at national or international level Habitats recognised as intact or unique (e.g. true deserts, fragile soils, wetlands) or areas recognised by NGOs as having high environmental value (e.g. Key Biodiversity Areas) Habitats that are unlikely to return to natural conditions without some intervention (such as re-seeding or planting), but which are capable of assisted recovery (including most semi-deserts) Habitats that can be classified as 'critical' in accordance with IFC Performance Standard 6 (IFC, 2012)
Ecosystem services	The ecosystem service is of low importance to beneficiaries (local,	The ecosystem service has moderate importance to beneficiaries and	The ecosystem service is of high importance to beneficiaries and has moderate replaceability

Receptor/impact	Sensitivity criteria		
	Low	Medium	High
	regional and global) or is of moderate importance but with many spatial alternatives available	moderate replaceability (some spatial alternatives), high importance to beneficiaries and many spatial alternatives, or low importance and few to no spatial alternatives	(some spatial alternatives); is of moderate importance to beneficiaries and has few or no spatial alternatives; or is essential to beneficiaries but has many spatial alternatives
Employment	Households with adequate employment / income to meet their basic needs, enjoying a standard of living above the local average Households with no individuals actively seeking work	Households with inadequate income to meet basic needs, and/or one or more members actively seeking work	Households with inadequate income and without an individual in regular or sufficient employment
Local communities	Middle to high-income persons or families Persons with ample access to goods and services	Middle-income persons or families with limited access to goods / services Nomads and semi-nomads who pass through the Project AOI	Low income or unemployed persons with no access, or severely limited access, to services Vulnerable households Nomads and semi-nomads who utilise the Project AOI to maintain their livelihood
Social cohesion	Occupants of well-established, existing households, not members of any marginalised group, permanently employed, and with sufficient resources to maintain livelihoods and security	Periodically employed persons and minority groups with no legal right to occupy their land/ homes	Highly vulnerable or sensitive populations or minority groups who perceive themselves as targets of discrimination
Local economy, markets and prices	Owners and employees of well-established businesses with secure contracts associated with the Project or Project-dependent services, fully able to maintain their market presence, or enterprises without any direct interest in oil-field-related business Well-paid or relatively wealthy residents, able to withstand price fluctuations	Owners and employees of small and medium-sized enterprises with a secure market position Businesses with an indirect interest, but not a wholly dependent relationship to the Project Middle-income household residents Producers or consumers of produce likely to be subject to price fluctuations	Owners and employees of businesses whose markets will be displaced or expanded by increased Project activity Any people or businesses subject to involuntary relocation or economic displacement Businesses which lose oilfield contracts on which they have been reliant, or which win significant new contracts on the Project New businesses created to take advantage of increased opportunities afforded by the Project

Receptor/impact	Sensitivity criteria		
	Low	**Medium**	**High**
			Marginalised people reliant on livelihoods unconnected to the oil industry, such as herders and producers of raw materials which are marketed remotely from the site, whose produce will not be subject to price inflation Poor households, i.e. those living below the national poverty line
Physical resources and infrastructure (e.g. utilities, transport network, educational, recreational)	Individuals or households with access to their own adequate and reliable facilities (e.g. transport, electricity, private education) and are not directly affected by changes to these utilities	Households which partially rely on affected infrastructure, including transport, recreation, electricity and/or education.	Households wholly dependent on affected public infrastructure for the supply of services or utilities
Road users (including pedestrians)	Convenient alternative routes available	Limited number of alternative routes available	No alternative route easily available
Reputation	The Project AOI does not include known culturally, environmentally or politically significant or sensitive areas	The Project AOI includes locally or nationally recognized, environmentally or politically significant or sensitive areas	The Project AOI includes internationally recognized, environmentally or politically significant or sensitive areas
Workers	Expat workers, highly-paid workers, temporary migrant workers with little or no long- term direct interest in the Project	Full-time local employees (including contractors)	Low paid/casual/occasional workers
Recruitment methods	Those already employed or not seeking employment	Project employees, seeking work for family members or friends	Unemployed, seeking work on the Project Tribal, ethnic or minority group members who perceive discrimination
Archaeology and cultural heritage	Archaeological and cultural heritage assets of local importance Archaeological and cultural heritage assets compromised by poor preservation, and/or poor survival of	Archaeological and cultural heritage assets or regional importance Archaeological and cultural heritage assets with potential to contribute to regional research objectives	Nationally and internationally significant archaeological and cultural heritage monuments protected by the Kurdistan government, Iraqi federal law and/or international conventions

Receptor/impact	Sensitivity criteria		
	Low	Medium	High
	contextual associations Archaeological and cultural heritage assets of limited value, but with potential to contribute to local research objectives Areas of negligible or low potential for previously unrecorded buried archaeology	Area where archaeological or other cultural heritage resources are present, and/or area where chance of disturbance of previously unknown or unrecorded buried archaeology is moderate	Undesignated sites of the quality and importance to be designated Assets that can contribute significantly to acknowledged national research objectives Area where significant or important archaeological or other cultural heritage resources are present, and/or area where chance of disturbance of previously unknown or unrecorded archaeology is high

APPENDIX 7
AIR QUALITY MODEL ASSUMPTIONS

The US Environmental Protection Agency (USEPA) AERMOD or CALPUFF models are used for evaluating the possible impacts of point source air emissions. This allows for assessing impact in a wider range of local meteorological conditions and also factors in the influence of terrain on dispersion. To perform the modeling study, USEPA recommends that equivalent emission parameters, referred to as 'Pseudo-parameters' have to be estimated for stack height, diameter and exit velocity. Pseudo-parameters account for hot, turbulent and buoyant plume.

These parameters do not necessarily have any physical relevance; however, they are calculated so as to simulate the movement of the exhaust plume as would be from a point source. The pseudo parameters calculated in this study and which was used for modeling are:

1) Effective Stack height

The effective stack height is the total height of the flare, including flame and nominal (physical) height of the flare. The following equation is used to estimate effective height:

$$H_{eff} = H_s + 4.56 \times 10^{-3} \times (Q_n/4.1868)^{0.478}$$

$$Q_n = Q_T \times (1-f)$$

Where:

H_s = Physical stack height above ground

H_{eff} = Effective stack height

Q_T = Total heat available from combustion in Joules/s,

F = % heat lost by radiation (a function of molecular weight of the flared gas stream)

Q_n = Net heat release

2) Effective exit velocity

Effective exit velocity is the velocity of the plume following combustion and is calculated as a representative value at the flame tip. Exit velocity of the plume is dependent on the 'lift rate' of the exhaust gases caused by the heat from combustion. While there is no specific threshold on gas exit velocity, the USEPA and other regulators have suggested a minimum gas exit velocity of 20m/s to provide sufficient momentum and prevent stack tip downwash.

3) Effective stack diameter

The effective stack diameter considers that the size of the flame and exhaust gases are potentially larger than original inner diameter or flare nozzle tip. Effective diameter is therefore calculated using the following formula:

$$D_{eff} = 2 \times \sqrt{(F_{b,actual} \times T_{stack})/(g \times V_{eff} \times (T_{stack} - T_{amb}))}$$

Where:

D_{eff} = effective diameter at the flame tip (m)

V_{eff} = effective exit velocity (m/s)

$F_{b,\,actual}$ = Heat released by combustion (m^4/s^3)

The calculated pseudo-parameters which were used as inputs to the modeling study, are presented in Table A7.1 below.

Table A7.1 Flare stack parameters for modeling

Sl NO	Source	Effective Height (m)	Effective Diameter (m)	Exit Velocity (m/s)	Stack Temp (K)	NO_2 (g/s)	SO_2 (g/s)	CO (g/s)	PM10 (g/s)
1	HP Flare (with LT Flare)	100.1	38.75	20	1273	64.30	97.63	349.87	50.95
2	LP Flare	40.22	7.56	20	1273	1.78	2.72	9.67	1.35
3	LLP Flare	29.27	2.77	20	1273	0.12	0	0.68	0.04

Receptors

Receptors were placed in a nested grid as described in Table A7.2 below (see also Figure A7.1). Receptors were placed to a distance of 50 km from the facility. Terrain elevations were extracted and assigned to the model domain from the SRTM 30 digital elevation model. Sensitive receptors were jointly identified with the client and are listed in the table below. Terrain elevations were processed and assigned to the receptors using AERMAP.

Table A7.2: Nested grid receptor spacing

Distance from Source	Spacing (m)
0-200	20
200-500	50
500-1000	100
1000-2000	200
2000-5000	500
5000-10000	1000
10000-20000	1000
20000-50000	5000

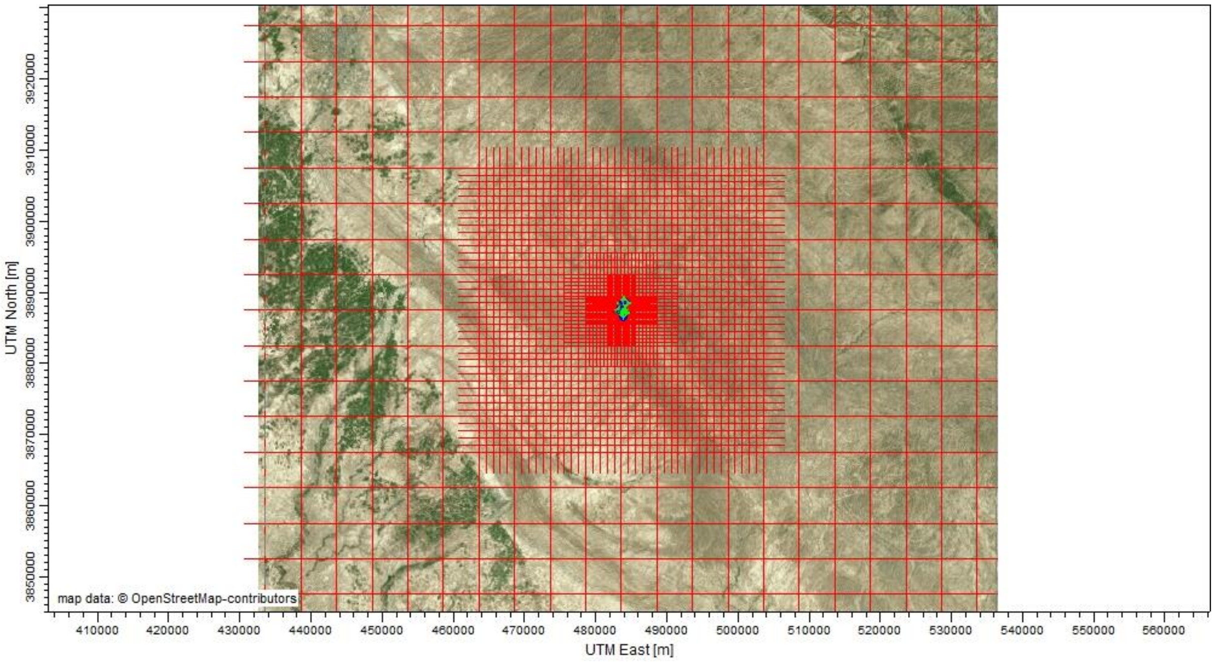

Figure A7.1 Nested receptor grid

APPENDIX 8
COMMITMENTS REGISTER

Table A8.1 Environmental commitments register

UNIQUE ID / NUMBER	COMMITMENT	Phase (select from list)	Action Owner
ENV01	Further evaluation during the detailed engineering phase including re-run of the air quality model with detailed design specifications to confirm compliance with the Project Standards.	Operations	Pearl Petroleum
ENV02	Consider alternative treatments of sour gas and evaluate compliance solutions during the detailed design phase.	Operations	Pearl Petroleum
ENV03	Undertake a quantitative impact assessment to evaluate the drawdown impact on local water users.	Construction	Pearl Petroleum
ENV04	Develop a Water Management Plan to ensure future sustainable management of water resources.	Construction	Pearl Petroleum
ENV05	Ensure that an abstraction permit is obtained from local authorities.	Construction	Pearl Petroleum
ENV06	Undertake refuelling at designated areas according to industry guidelines.	Construction	Pearl Petroleum
ENV07	Store chemicals and hydrocarbons within secondary containment and according to Good International Industrial Pratices (GIIP).	Construction	Pearl Petroleum
ENV08	Adopt quiet working methods, where reasonably practicable, using plant with lower noise and vibration emissions.	Construction	Pearl Petroleum
ENV09	Avoid or limit noisy construction activities during the night-time period.	Construction	Pearl Petroleum
ENV10	Use acoustic screens and/or enclosures for static items of plant which generate noise levels that have the potential to cause disturbance.	Construction	Pearl Petroleum
ENV11	Carry out regular inspections of noise mitigation measures to ensure integrity is maintained at all times.	Construction	Pearl Petroleum
ENV12	Provide briefings for all site-based personnel so that noise issues are understood, and mitigation measures are adhered to.	Construction	Pearl Petroleum
ENV13	Produce a Biodiversity Management Plan (to include bio-security and bio-restoration).	Construction	Pearl Petroleum
ENV14	Undertake a preconstruction survey for important plant species in areas identified as potential habitat in particular along flowlines where routes are likely to be re-surveyed.	Construction	EPC Contractor
ENV15	Evaluate practical alternatives to avoid or reduce impacts to the important plant species if these species are identified within areas subject to land disturbing activities.	Construction	EPC Contractor
ENV16	Prohibit the collection of natural resources, such as plant materials for firewood, food or medicine.	Construction	EPC Contractor
ENV17	Use appropriate technique (seed harvesting/cutting/translocation) to move individual plants from the construction footprint if the individual cannot be avoided during land disturbing activities.	Construction	EPC Contractor

ENV18	Undertake site clearance with due consideration to main breeding season.	Construction	EPC Contractor
ENV19	Establish a 10 m buffer zone, if possible and practical, around the burrow or nest where no construction may occur until monitoring indicates that the species has left the nest/burrow.	Construction	EPC Contractor
ENV20	Evaluate alternatives to relocate the species, if sensitive species active nest or burrow cannot be avoided; and seek approval from regulator.	Construction	EPC Contractor
ENV21	Prohibit deliberate disturbance of killing of fauna by site workers - any unintentional killing or injury of species to be reported and tracked internally.	Construction	EPC Contractor
ENV22	Limit vegetation removal to the extent possible.	Construction	EPC Contractor
ENV23	Consider animal bypass around flowline construction zones, as deemed necessary.	Construction	EPC Contractor
ENV24	Restore habitats in temporary workspaces after construction activities are complete including returning the segregated topsoil to the site and restore ecology with native species.	Construction	EPC Contractor
ENV25	Reduce the time between construction and reinstatement for works undertaken in sensitive habitats to the extent possible.	Construction	EPC Contractor
ENV26	Ensure that the Waste Management Plan (WMP) provides for avoidance of waste storage or other waste management procedures that reduce potential forage by nuisance species.	Construction	EPC Contractor
ENV27	Undertake toolbox talks with staff to educate them on what species are likely to be present on-site and on correct actions to be taken if any animals are encountered.	Construction	EPC Contractor
ENV28	Limit office operations to daylight hours, where possible.	Operations	EPC Contractor
ENV29	Develop and implement a Lighting Plan (LP) for the new and existing faculties to limit spread by using directional lighting, hoods, etc. and only light the working areas.	Operations	EPC Contractor
ENV30	Discussion should be held with the Ministry of Natural Resources and other parties regarding the fate of buried pipelines which are sometimes left in place subsequent to decommissioning by agreement of all parties.	Construction	Pearl Petroleum
ENV31	This risk will be further reduced by recycling and reuse of materials/equipment where possible offsite.	Construction	Pearl Petroleum

Table A8.2 Social commitments register

UNIQUE ID / NUMBER	COMMITMENT	Phase (select from list)	Action Owner
SOC01	Prioritise the sourcing of goods and services from local and regional businesses, providing required quality and delivery timescales can be met.	Construction Pre-commissioning Decommissioning	Pearl Petroleum
SOC02	Support the development and capacity building of local and regional businesses, either directly or as part of government of sector-wide initiatives.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC03	Compile an annual environmental and social performance report, made available to stakeholders, which details how local and regional businesses have been prioritised in the sourcing of goods and services and provided with capacity building support.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC04	Prior to construction, undertake a benchmarking exercise to gather data on the average price of local basic good and services; use the data to monitor changes in the cost of goods and services against baseline conditions.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC05	Implement a comprehensive Social Monitoring Plan that includes monitoring socio-economic changes in local communities (e.g. in living standards, household well-being and other daily necessities) through regular community meetings and through regular price surveys.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC06	Undertake targeted engagement with vulnerable people should local price inflation become an issue. Design and implement additional support measures (e.g. the provision of goods to vulnerable people) on a case-by-case basis with support from third parties (e.g. development agencies) as appropriate.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC07	Extend the existing Community Grievance Management Procedure to the KM250A Project to ensure that Project affected communities and other stakeholders have unrestricted access and opportunity to raise concerns and grievances related to the Project.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC08	Develop an Influx Management Strategy (including a 'no hiring at the gate' policy), providing clear information on the scale, scope and process of accessing Project-related employment and business opportunities.	Construction	Pearl Petroleum EPC Contractor

SOC09	Provide information on the Project's recruitment strategy and key messages about the scale, scope and process of accessing Project-related employment and business opportunities to local communities to ensure that stakeholder expectations are suitably managed.	Construction	Pearl Petroleum
SOC10	Include similar information and messages in the worker codes of conduct in order to ensure that accurate information is conveyed to interested parties.	Construction	Pearl Petroleum EPC Contractor
SOC11	Ensure that the Social Monitoring Plan (see SOC05) includes monitoring changes in population size and the arrival of economic migrants .	Construction	Pearl Petroleum
SOC12	Work with, and where feasible support, local authorities in planning for and managing the spatial changes (e.g. in land use) and increasing demands on infrastructure and services that occur as the local area surrounding the Project grows.	Construction	Pearl Petroleum
SOC13	Prioritise employment of people from local communities, followed by people from other parts of the Kurdistan Region.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC14	State the proportion of workers who will be hired from local communities and/or the wider region in order to maximise their employment opportunities.	Construction Pre-commissioning Operations	EPC Contractor
	Oversee Contractors' recruitment activities to ensure adherence to local hiring requirements.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC15	Give information about the Project's recruitment strategy and key messages about the scale, scope and process of accessing Project-related employment and business opportunities to local communities to ensure that stakeholder expectations are suitably managed.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC16	At the end of employment, formally recognise workers' involvement in the Project through the provision of references and/or certificates outlining workers' job role(s), the duration of their employment and other details (e.g. training undertaken) as appropriate.	Construction	Pearl Petroleum EPC Contractor
		Pre-commissioning	Pearl Petroleum EPC Contractor
		Operations	Pearl Petroleum EPC Contractor
SOC17	As part of the tendering process, include training and competency development in order to support capacity building amongst the Project workforce and within the Project supply chain, and provide formal recognition of this training for workers (e.g. through references and/or certifications) where possible.	Construction Pre-commissioning Operations	EPC Contractor

SOC18	Provide on-the-job training to the Project workforce in order to enable workers to gain new or improved skills and provide formal recognition of this training (e.g. through references and/or certifications) to workers where possible.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC19	Ensure that the proportion of foreign workers is reduced and replaced by personnel who come from local communities and other parts of Kurdistan.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC20	Gather data on average incomes associated with the public and private sector to benchmark wage levels in the local area; use the data to benchmark wage levels in the local area (this should be coordinated with SOC05).	Construction Pre-commissioning Operations	Pearl Petroleum
SOC21	Ensure that the Social Monitoring Plan (see SOC05) includes sources of employment and changes in wage levels.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC22	Review the existing process for recruitment to ensure that it is able to cope with an increase in the number of jobs available as a result of the Project; make changes to the existing process as appropriate.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC23	Where appropriate, develop a Local Community Employment Plan (LCEP), which will become part of the existing Local Goods and Services Plan, prioritising the employment of people from local communities, followed by people from other parts of the Kurdistan Region.	Construction Pre-commissioning	EPC Contractor
	Oversee contractors' recruitment activities to ensure adherence to local hiring requirements.	Construction Pre-commissioning	Pearl Petroleum
SOC24	Manage overall relationship with local communities through a range of strategies, including regular engagement and ongoing social investment. Include long-term capacity building and skills development programmes in the latter.	Construction Pre-commissioning Operations Decommissioning	Pearl Petroleum

SOC25	In the Local Community Employment Plan (see SOC23), include provisions to ensure that Project employment opportunities for local people reflect engagement with local authorities and are perceived to be equitably distributed across the communities through ongoing engagement with village Anjuman.	Construction Pre-commissioning Operations	EPC Contractor
SOC26	Internally review existing systems for managing conflict, for example grievances and road blocks, to ensure that they are sufficiently robust to manage conflicts which may arise as a result of the Project; make changes to existing systems as appropriate.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC27	Develop retrenchment plans with the aim of ensuring social cohesion and reducing the impacts of the termination of employment contracts.	Construction Pre-commissioning Decommissioning	EPC Contractor
SOC28	During the recruitment process, and for the duration of their employment, ensure transparency with workers regarding the temporary nature of their employment on the Project and regularly remind workers of this fact. Clearly state the duration of workers' employment in their employment contracts and discuss with workers the need to prepare for the termination of their employment contracts. See also SOC22 and SOC23.	Construction	Pearl Petroleum EPC Contractor
		Pre-commissioning	Pearl Petroleum EPC Contractor
		Decommissioning	Pearl Petroleum Other contractor
SOC29	Select contractors through a robust pre-qualification and due diligence process and include standards on labour and working conditions, aligned with those prescribed by the International Finance Corporation (IFC), in all contractual documents.	Construction Pre-commissioning Operations Decommissioning	Pearl Petroleum
SOC30	Ensure that KM250A worker grievance procedures are developed and implemented in compliance with Pearl Petroleum's overarching worker grievance procedure and are available for use by all workers.	Construction	EPC Contractor
		Pre-commissioning	EPC Contractor
		Decommissioning	Other contractor
	Approve contractors' worker grievance procedures (which should align with the existing Worker Grievance Management Procedure).	Construction	Pearl Petroleum
		Pre-commissioning	Pearl Petroleum
		Decommissioning	Other contractor
SOC31	Hold regular meetings (e.g. toolbox talks) with Project personnel, including contractor and sub-contractor employees, to ensure that workers are satisfied with their employment and workplace; provide opportunities for workers to raise concerns and report problems at these meetings.	Construction	Pearl Petroleum
		Pre-commissioning	Pearl Petroleum
		Operations	Pearl Petroleum
		Decommissioning	Pearl Petroleum

SOC32	As part of the worker induction process, explain to employees (including sub-contractor employees) their legal rights and entitlements alongside the content of their employment contracts.	Construction	EPC Contractor
		Pre-commissioning	EPC Contractor
		Operations	Other contractor
		Decommissioning	Other contractor
SOC33	Where appropriate and feasible, oblige each contractor to be transparent on their supply chain. Undertake a risk-based screening assessment to prioritise the types of goods and services to be procured; subject these goods and services to an audit against national and regional regulatory requirements and international standards.	Construction	Pearl Petroleum
		Pre-commissioning	Pearl Petroleum
		Decommissioning	Pearl Petroleum
SOC34	Develop and implement contractor Health and Safety Plans and Work Management Procedures that align with the existing Pearl Petroleum Occupational Health and Safety Plan.	Construction	EPC Contractor
		Pre-commissioning	EPC Contractor
		Decommissioning	Other contractor
	Approve contractors' Health and Safety Plans and Work Management Procedures; undertake auditing to ensure contractor compliance with these plans and procedures.	Construction	Pearl Petroleum
		Pre-commissioning	Pearl Petroleum
		Decommissioning	Pearl Petroleum
SOC35	Develop and implement Occupational Health and Safety (OHS) training programmes that are culturally and linguistically appropriate; update training programmes based on changes in the scope of work being undertaken, incident statistics and regulatory requirements.	Construction	Pearl Petroleum
			EPC Contractor
		Pre-commissioning	Pearl Petroleum
			EPC Contractor
		Operations	Pearl Petroleum
		Decommissioning	Pearl Petroleum
			Other contractor
SOC36	Ensure that remuneration is justified and adequate for the level of expertise and experience provided; include details of remuneration in employment contracts with workers (including sub-contractor workers).	Construction	EPC Contractor
		Pre-commissioning	
		Decommissioning	Other contractor
SOC37	Ensure that no Project land take will occur unless the process of the corresponding KRG agency has been completed such that timely compensation is paid to Project-affected persons (PAPs), including land users (e.g. livestock rearers). Pearl Petroleum to prevent access to land by Project personnel (including Pearl Petroleum staff, contractors and sub-contractors) if there is no consent or agreement in place. See also SOC38.	Construction	Pearl Petroleum
SOC38	Develop and implement a Livelihood Restoration Plan (LRP) to address the short- and long-term economic impacts from temporary and permanent (life of Project) loss of access to land. Include, in the LRP, a gap analysis of the differences between international standards and regional processes, principles of land access, an entitlements matrix based on a mitigation and compensation framework, details of the valuation of assets and establishment of compensation rates, the land access procedure, provisions for vulnerable people, Management of Change Procedure and monitoring and evaluation. Integrate the LRP (where relevant and appropriate to do so) with the Rental Value and Compensation Committee's own activities.	Construction	Pearl Petroleum

SOC39	Support the Livelihood Restoration Plan (LRP) by stakeholder engagement with the Project affected people (PAPs) to ensure that the livelihood restoration strategy is clearly explained and accepted, that the approach to legacy issues is clear and that PAPs understand that they are all treated equally. See also SOC38.	Construction	Pearl Petroleum
SOC40	Monitor the Livelihood Restoration Plan (LRP) for a period of up to five years following implementation to assess the effectiveness of livelihood restoration measures; implement corrective actions, as appropriate. See also SOC38.	Construction	Pearl Petroleum
SOC41	Agree a cut-off date with the Government prior to the commencement of survey activities for the Livelihood Restoration Plan (LRP) and clearly communicate the cut-off date to the Project affected people. See also SOC38.	Construction	Pearl Petroleum
SOC42	Develop and implement land entry, exit and reinstatement procedures on third party lands, including information to affected land owners and land users. See also SOC38.	Construction	EPC Contractor
SOC43	Seek to support the efforts of local authorities in resolving existing conflicts over land in the Project area.	Construction	Pearl Petroleum
SOC44	Undertake regular meetings with village Anjuman and local communities, including the Project affected people (PAPs), to ensure that information about the Project's land acquisition and compensation strategy is clearly communicated and that stakeholder concerns are effectively addressed. See also SOC05.	Construction	Pearl Petroleum
SOC45	Undertake pre-construction surveys to identify any watering wells and pasture land to which access must be maintained.	Construction	EPC Contractor
SOC46	Leave gaps in soil stacks and pipe stings along the right of way to ensure that access to watering wells and pasture land is maintained. Provide crossing points across open trenches and welded pipes as necessary.	Construction	EPC Contractor
SOC47	In the event that loss of access to watering wells and/or pasture land is unavoidable, provide alternative water supplies and pasture land/appropriate compensation in line with the Livelihood Restoration Plan (LRP). See also SOC38.	Construction	Pearl Petroleum
SOC48	Identify risks in health and safety plans and work management procedures and, within this, include provisions to ensure community safety, including safety barriers (e.g. fences) around open excavations to prevent local communities and livestock from falling into trenches.	Construction	EPC Contractor
SOC49	Post culturally appropriate safety signage and information in local communities and near to work sites to raise awareness about risks to the safety of persons and livestock.	Construction	Pearl Petroleum EPC Contractor
SOC50	Develop and implement a community safety awareness campaign in local communities with a particular focus on high-risk groups (e.g. children), potentially involving school visits to raise awareness on road safety risks.	Construction	Pearl Petroleum
SOC51	Where appropriate, develop a work-specific Traffic Management Plan (TMP) that aligns with the Pearl Petroleum Traffic Management Plan and that identifies sensitive social receptors along transportation routes and outlines mitigation measures (e.g. speed limit restrictions, vehicle maintenance activities, awareness campaigns, recruitment of traffic wardens) to reduce the risk of road traffic accidents occurring.	Construction	EPC Contractor

SOC52	Develop and implement Workers' Codes of Conduct (that aligns with the Pearl Petroleum Worker and Security Code of Conduct), inclusive of training for all Project personnel on local customs, culture and tradition, interacting with local communities, expected behaviour and the Community Grievance Management Procedure. Deliver training as part of the worker induction process and ensure that compliance with workers' codes of conduct is a contractual requirement for all employees.	Construction Pre-commissioning	EPC Contractor
		Decommissioning	Other contractor
	Approve Workers' Codes of Conduct developed by contractors.	Construction Pre-commissioning Decommissioning	Pearl Petroleum
SOC53	Prohibit the out-of-hours movement of non-local workers (from other parts of Kurdistan or further afield) for reasons not related to work, in accordance with construction camp rules.	Construction Pre-commissioning Decommissioning	Pearl Petroleum
SOC54	Review established arrangements for security provision at the existing facility to ensure that they are sufficiently robust to manage security issues which may arise as a result of the Project; make changes to existing arrangements, as appropriate.	Construction Pre-commissioning Decommissioning	Pearl Petroleum
SOC55	Ensure that training for Project security personnel includes rules of engagement and human rights (e.g. the Voluntary Principles of Security and Human Rights).	Construction Pre-commissioning Operations Decommissioning	Pearl Petroleum
SOC56	Undertake regular meetings with village Anjuman and local communities to ensure that information about the Project is clearly communicated and that stakeholder concerns are effectively addressed.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC57	Ensure that the Social Monitoring Plan (see SOC05) provides for monitoring relations between local communities and the Project and any changes in perceptions towards Pearl Petroleum.	Construction Pre-commissioning Operations Decommissioning	Pearl Petroleum
SOC58	Provide local communities with regular updates on the Project through community meetings; integrate reporting to local communities within the overarching Stakeholder Engagement Plan (SEP) implemented at the existing facility. See also SOC03 and SOC24.	Construction Pre-commissioning Operations Decommissioning	Pearl Petroleum
SOC59	Review the KM250A Project Stakeholder Engagement Plan (SEP) periodically to ensure that information on Project activities such as the potential for non-routine flaring events to occur occasionally is included; make updates to the SEP, as appropriate.	Operations	Pearl Petroleum

SOC60	Include provisions in contractor Health and Safety Plans to ensure the fitness of workers (e.g. pre-deployment medical screenings which includes tests for communicable diseases) during the recruitment process.	Construction Pre-commissioning Operations Decommissioning	EPC Contractor
SOC61	Include health and hygiene training for all employees, including sub-contractor employees, in health and safety plans to minimise the spread of communicable diseases.	Construction Pre-commissioning	EPC Contractor
		Decommissioning	Other contractor
SOC62	Identify the risks to public health associated with their scope of work in Health and Safety Plans and detail mitigation measures as appropriate.	Construction Pre-commissioning Operations Decommissioning	Pearl Petroleum
SOC63	Undertake a pre-construction survey to assess the condition of roads to be used by the Project (including but not limited to traffic signage, bridges and other road infrastructure).	Construction	Pearl Petroleum EPC Contractor
SOC64	Undertake a post-construction survey covering all of the areas surveyed pre-construction to assess the condition of roads and road-related infrastructure used by the Project; close out any actions (e.g. repairs) arising from the post-construction survey in a timely manner.	Construction	Pearl Petroleum EPC Contractor
SOC65	Include in In Traffic Management Plan(s) (TMPs) (see SOC51) any necessary restrictions on vehicle movements to defined access routes and demarcated work areas.	Construction Operations	EPC Contractor
SOC66	As part of the worker induction process, communicate that medical assistance to all employees (including sub-contractor employees) is provided by the Project; prohibit workers from using local health services at this time.	Construction Pre-commissioning	EPC Contractor
		Decommissioning	Other contractor

SOC67	Monitor water supplies in local communities against baseline conditions; integrate this monitoring into monitoring plans implemented at the existing facility.	Construction Operations	Pearl Petroleum
SOC68	Develop and implement water efficiency training programmes in local communities with the aim of promoting sustainable water consumption.	Construction Operations	Pearl Petroleum
SOC69	Undertake pre-construction surveys to identify community infrastructure (e.g. bridges, electricity pylons, power lines) which will need to be upgraded, moved or potentially damaged by the Project.	Construction	Pearl Petroleum EPC Contractor
SOC70	Communicate any planned activities which may affect community infrastructure (e.g. bridges, electricity pylons, power lines) to local authorities and affected communities in a timely manner; ensure that information provided stakeholders includes (but is not limited to) the nature, timing and duration of the planned activities.	Construction	Pearl Petroleum
SOC71	Repair any damage to community infrastructure in a timely manner.	Construction	EPC Contractor
SOC72	Request permission from the Erbil Directorate of Roads and Bridges to implement any road diversion; provide prior notification to the public and appropriate road signage before any road diversions.	Construction Operations Decommissioning	Pearl Petroleum
SOC73	Seek to avoid diversions during peak hours or creating blockages or diversions during peak activities on weekends.	Construction Operations Decommissioning	Pearl Petroleum
SOC74	Monitor the physical condition of the road on an as needed basis in order to raise concerns and work with the local governments to make repairs.	Construction Operations Decommissioning	Pearl Petroleum
SOC75	Provide targeted assistance, where possible and appropriate, to vulnerable groups identified in the KM250A Project Stakeholder Engagement Plan (SEP) to ensure that they have equal access to Project-related information and equal opportunities to raise questions and concerns.	Construction Pre-commissioning Decommissioning	Pearl Petroleum
SOC76	Ensure that recruitment processes for the Project are based on the skills required for the role with no discrimination according to age, sexuality or gender, ethnicity, religion and/or political opinion.	Construction Pre-commissioning Operations	Pearl Petroleum

SOC77	Continue to provide illiterate persons with additional support when applying for jobs on the Project.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC78	Develop and implement a gender inclusion strategy (as part of the existing Pearl Petroleum Social Performance Standard) containing various measures to promote the inclusion of women in the Project. Consider including recruitment targets for women for contractors and sub-contractors, provisions to ensure women feel safe in the workplace and in Project accommodation and provisions to ensure that women are fairly engaged with during the recruitment process. Where appropriate and feasible, work in partnership with third parties (e.g. development agencies) to develop and implement the gender inclusion strategy.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC79	Assess the potential risks that may be associated with women’s participation in the Project and identify measures to mitigate these risks in the short-, medium- and long-term as part of the gender inclusion strategy. Consider targeted engagements with men to raise awareness about the benefits associated with women's involvement in the Project.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC80	Undertake a comprehensive survey to establish the vulnerability of flowline land owners and land users as part of the Livelihood Restoration Plan (LRP) (see also SOC38).	Construction	Pearl Petroleum
SOC81	Based on the results of the survey, specify in the Livelihood Restoration Plan (LRP) additional support measures to ensure that vulnerable people are not disadvantaged during the Project land acquisition and compensation process (see also SOC38).	Construction	Pearl Petroleum
SOC82	Ensure that the KM250A Project Stakeholder Engagement Plan (SEP) provides special measures, where possible and appropriate, to ensure that women have equal access to Project-related information and equal opportunities to raise questions and concerns.	Construction Pre-commissioning Operations	Pearl Petroleum
SOC83	Develop and implement a targeted community information campaign on hydrotesting to ensure that local communities understand the noise, water and any other impacts associated with this exercise.	Pre-commissioning	Pearl Petroleum
SOC84	Seek to maximise the Project's contribution to the development of Kurdistan's oil and gas sector and regional economic growth through, for example, considering opportunities to work with universities as part of its Social Investment Programmes.	Operations	Pearl Petroleum
SOC85	Develop a draft plan for providing transition training to allow skilled employees to better access employment in other sectors; evaluate the level of interest in such training amongst workers prior to the finalisation and implementation of the plan.	Operations	Pearl Petroleum
SOC86	Where the Project affects the livelihood activities of crop farmers, provide appropriate compensation in line with the Livelihood Restoration Plan (LRP).	Operations	Pearl Petroleum

SOC87	Post culturally appropriate safety warnings and information in local communities and near to Project infrastructure to raise awareness about the risks of interfering or tampering with Project infrastructure.	Operations	Pearl Petroleum
SOC88	Develop and implement community safety awareness campaigns in local communities with the aim of discouraging interference or tampering with Project infrastructure.	Operations	Pearl Petroleum
SOC89	Develop and implement measures to reduce the impact of night-time non-routine flaring, for example installation of glazed windows or shades for residences with a clear view of flare flames.	Operations	Pearl Petroleum
SOC90	Develop and implement programmes which promote the long-term sustainability and independence of communities. Consider the avoidance of dependency will in the design of all Social Investment Programmess (SIPs) and consider planning for the end of Pearl Petroleum interventions from the outset.	Decommissioning	Pearl Petroleum
SOC91	Consider technical solutions to sharing costs and accountability for the provision of power and water.	Decommissioning	Pearl Petroleum
SOC92	Consider prioritising social investment that diversifies the local economy and reduces local communities' reliance on Pearl Petroleum at Khor Mor.	Decommissioning	Pearl Petroleum
SOC93	Consider skills and training to support regional development priorities.	Decommissioning	Pearl Petroleum
SOC94	Consider strategic engagement structures, such as community committees and participatory monitoring, to build community capacity to manage their development.	Decommissioning	Pearl Petroleum
SOC95	Consider leveraging its operations at Khor Mor to encourage other development actors to engage in the area.	Decommissioning	Pearl Petroleum
SOC96	Consider working in partnership with third parties (e.g. development agencies) to implement its Social Investment Programmes (SIPs).	Decommissioning	Pearl Petroleum